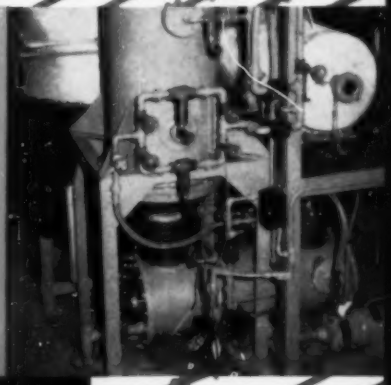
JANUARY 1958

CEP

CHEMICAL ENGINEERING PROGRESS

Report on year-long operation of new process for acetylene-ethylene from natural gas.



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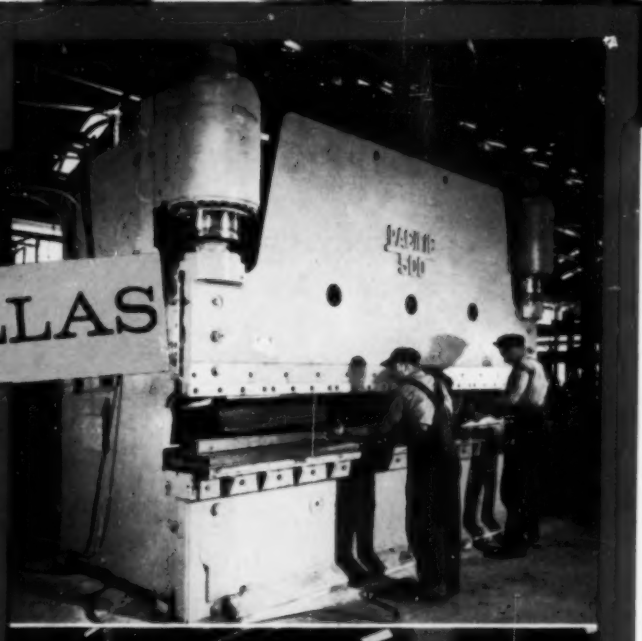

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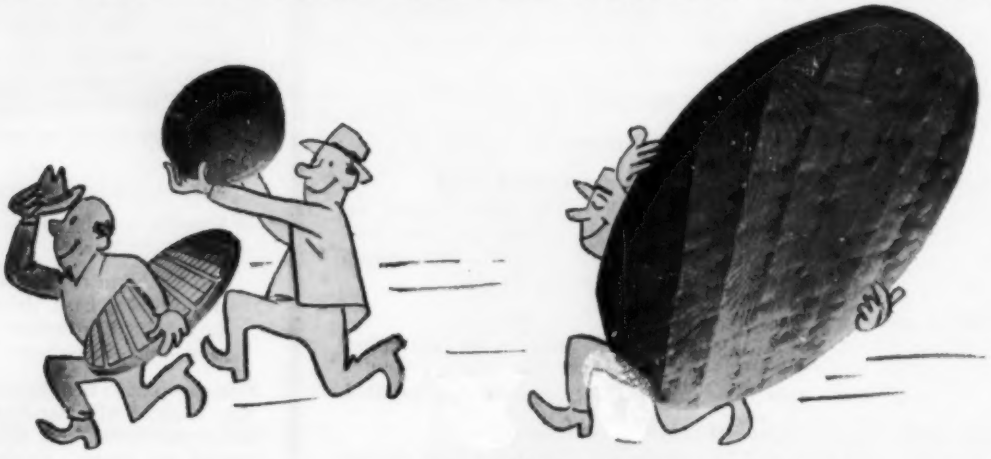

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Published monthly by American Institute of Chemical Engineers at 15 North Seventh Street, Philadelphia 6, Pennsylvania. Editorial and Advertising Offices, 25 West 45th Street, New York 36, N. Y. Communications should be sent to the Editor. Statements and opinions in *Chemical Engineering Progress* are those of the contributors, and the American Institute of Chemical Engineers assumes no responsibility for them. Subscriptions: U. S. and possessions, one year $6.00; two years $10.00 (Applies to U. S. and possessions only). Canada, $6.50; Pan American Union, $7.50; Other Foreign, $8.00. Single copies of *Chemical Engineering Progress* older than one year cost $1.00 a copy; others are 75 cents. Entered as second class matter December 9, 1948, at the Post Office at Philadelphia, Pennsylvania, under Act of August 24, 1912. Copyright 1958 by American Institute of Chemical Engineers. Member of Audit Bureau of Circulations. *Chemical Engineering Progress* is indexed regularly by Engineering Index, Inc.

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SHALL WE REVAMP THE ATOMIC ENERGY COMMISSION?

Although we often lose sight of the tremendous accomplishments of the AEC during the many debates, often political, we are dependent upon suggestions and criticisms for the development of improved programs. Further, we expect that the individuals responsible for policy decisions will respond to the pressures to which they are subjected. A major strength of our society is the encouragement of critical discussions, with strong attacks and defenses, but with honest and sincere arguments and interpretations.

Perhaps it is in this light that we should examine in detail the reprint in the November, 1957, issue of *CEP* (p. 6) of the talk given by AEC Commissioner Harold S. Vance on the basic philosophy of the Atomic Energy Commission. The purpose of the talk was to air the misconceptions and the lack of understanding of AEC policy.

The Commission refers to ". . . a recent speech of a well-known educator who said in effect that the time has come when the Atomic Energy Commission should be liquidated because of its sinister purposes." Submitted to the Editor herewith is the recent speech by a well-known educator, Dean Athelstan Spilhaus, who offered a friendly indictment that the AEC has outlived its usefulness. The readers can judge for themselves the accuracy of the Commissioner's interpretation. I believe that Commissioner Vance's plea for a better understanding has been to some extent the result of compounding a misconception.

Herbert S. Isbin
Minneapolis, Minnesota

Following is the text of the talk by Mr. Spilhaus as it was delivered to CEP *by Mr. Isbin.*

Athelstan Spilhaus *

Dean of the Institute of Technology
University of Minnesota, Minneapolis, Minnesota

After the fullest recognition of the magnificent if frightening accomplishments during its existence, I believe the Atomic Energy Commission has outgrown its usefulness. I believe that it is time to separate out into the normal elements of the pattern of our society the many-fold functions of the commission.

We have proven and tested patterns in American society and in our democratic form of government. Some of these patterns are: the normal agencies of government (both state and federal), our great universities, and our imaginative and competitive system of private enterprise.

In the very best ordered society or organization it is sometimes necessary to set up a special group or agency (temporarily, if possible) to meet a new challenge. Such was the case in the Atomic Energy Commission.

The Atomic Energy Commission was established because the first applications of atomic energy emerged in secrecy for wartime purposes. It was necessary at that time to have a special group to guide these applications during the transition period into permanent channels.

We must therefore accept the idea that the Commission was to effect a transition.

One measure of such a (transitional) commission's success is how smoothly, rapidly, and efficiently it eliminates the need for itself. And this it should do by seeking ways to pass on its work to appropriate, competent, permanent organizations so that they may be able to take over.

The Atomic Energy Commission has failed in this respect in that during 10 years it has not substantially reduced the activities under its direct or indirect control. It has not pursued vigorously enough the aim of getting itself out of business.

On the contrary it has become a monopoly in the area of nuclear energy which is broadening its scope to embrace all aspects of high energy physics and their potential applications.

In doing so, the Commission dominates, in its too little understood and too loosely defined field of "atomic energy," research education, private exploitation to develop useful outcomes, and even usurps controls in atomic energy which should become logical extensions of the separable functions of numerous long-established departments of our government.

It is time that university research in modern physics be freed of any of the controls that accompany Commission support. University people have been unusually productive historically if given the means and left alone.

Our private initiative and competitive system of industry has traditionally been the tremendously successful place where ideas are turned into things for better living.

It is time that much more information be made openly and quickly available on a wider scale to permit industry to bring its collective strength to bear on the development of peaceful application of atomic science.

There are, of course, certain functions and controls which properly should rest with the government—such things as the development of nuclear weapons, insuring the secrecy of such developments, and safeguarding the nation from hazards to health and well being that may result from them.

Even these, that are proper tasks of government, are not best carried out under one closely held group. It is time that they were split up and that appropriate permanent division in government be charged with their execution.

I have said that I believe that if

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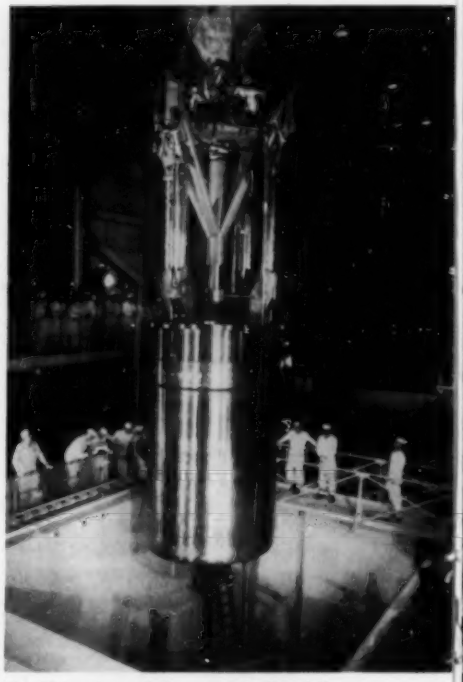

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* In a speech before the American Society of Newspaper Editors.

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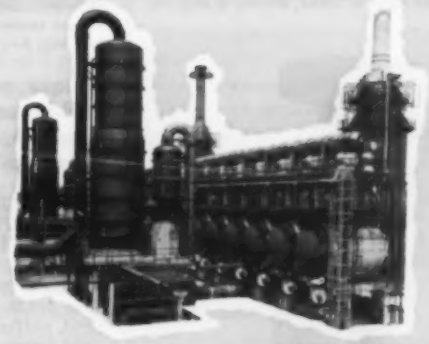

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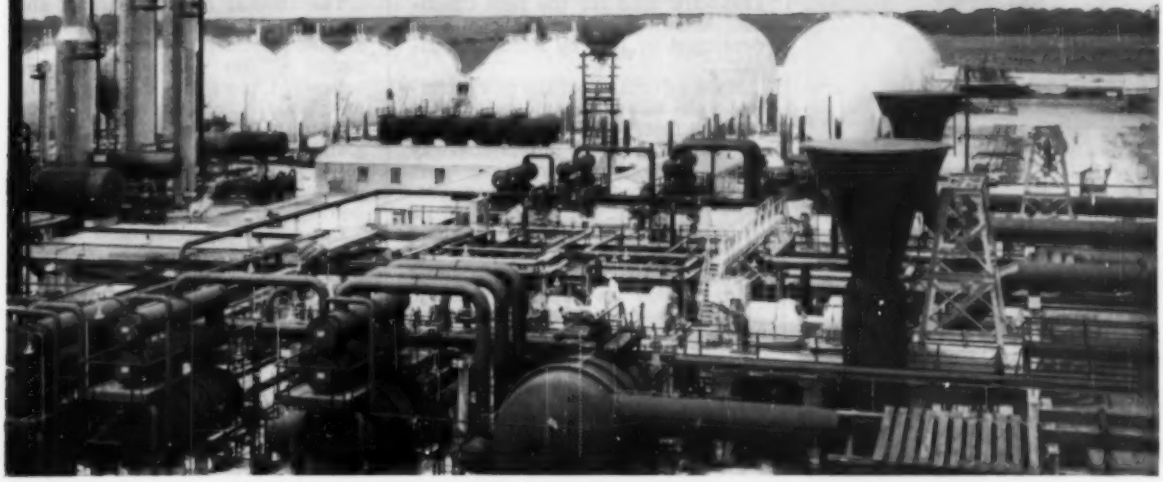

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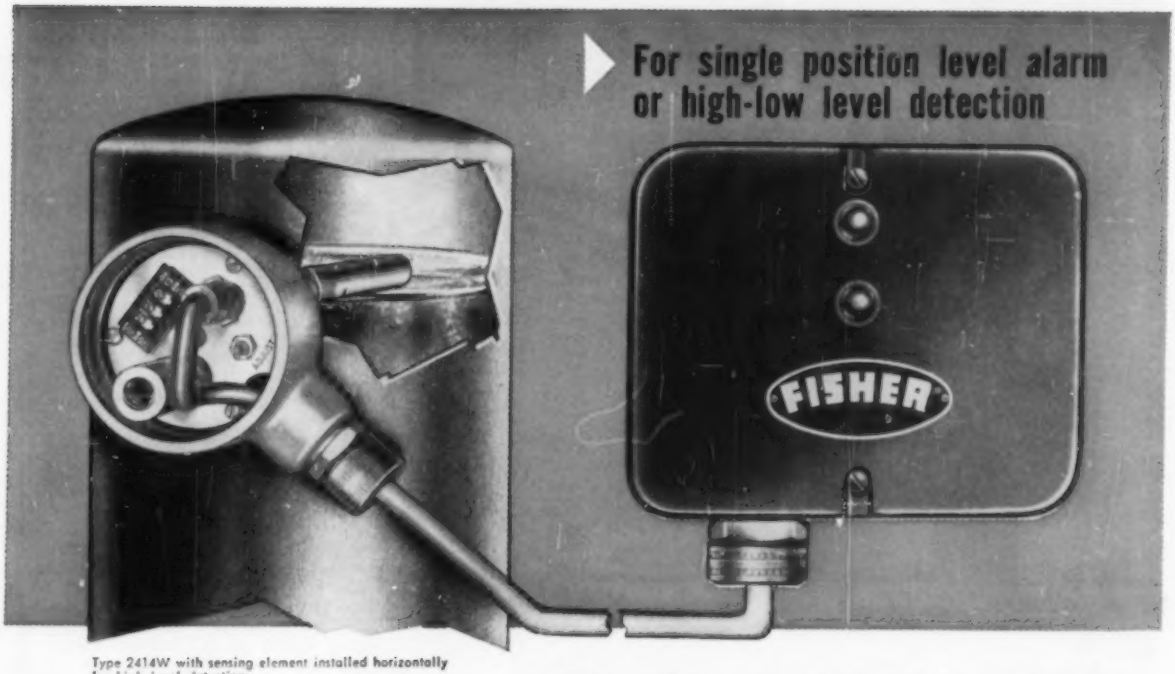

Type 2414W with sensing element installed horizontally for high level detection.

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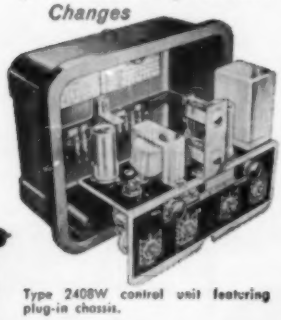

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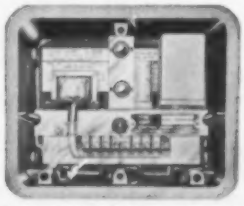

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Noted and quoted

(*Continued from page 6*)

the numerous functions with which the Commission is now charged were separated out in normal elements of our society and government, some other serious problems would be in the seriousness of their impact. Take as an example the recent nationwide discussion on fall-out and radiation effects.

Here again, the trouble comes, I think, from the Atomic Energy Commission's having too many functions under one head. It is most difficult for those who make and test bombs to be as well the arbiters of the health hazards that these produce and in addition to have to pass final judgment and enforce controls.

The U.S. Public Health Service watches over health hazards to the nation except atomic energy.

The Department of Defense is charged with all weapons development —except nuclear weapons.

The Federal Power Commission is concerned with all aspects of power—except nuclear power.

The Department of Commerce both stimulates and controls commercial development—except atomic applications.

And so on through the other departments of government.

In each case the normal extension of the functions of these permanent departments to include their proper concern with atomic energy is inhibited by the overriding mandate with which the Commission is charged.

It can be freely admitted that certain government agencies may not be able, at the present time, to discharge these duties as well as the AEC.

But the way to correct this is to strengthen them to enable them to take over the extension of their normal responsibilities, not to weaken them by perpetuating a special agency to do part of their job.

It is our government's stated policy to stimulate industry's role in the development of atomic energy application, yet there are still major stumbling blocks in getting the necessary fresh information initially to the potential contribution . . .

Fresh information is necessary to get the idea that establishes the "need to know" that opens the door to fresh information. And so the tiger chases its tail around the tree.

If the responsibility of the development of nuclear weapons and nuclear power were separated in a clear-cut fashion, then surely at least some of the secrecy attached to bombs would not flow over and obscure the power area. A freer flow of fresher information should certainly result in stimulating a greater contribution from industry.

Separation of other parts of the atomic energy program and delegation to other departments would have a similarly desirable effect of reducing the need for secrecy in a number of areas.

Another part of the effect of overcentralization and control is the control that the Commission is gaining in research and education. And this is not only in a limited area of nuclear energy

(*Continued on page 12*)

How "Containerization"
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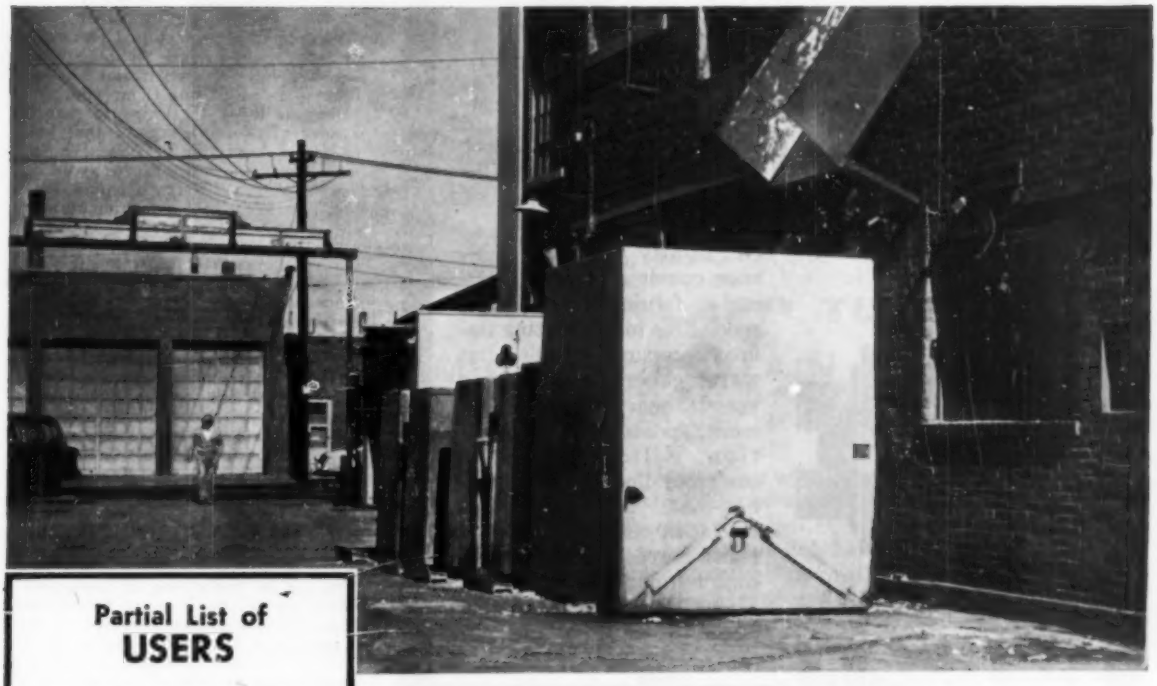

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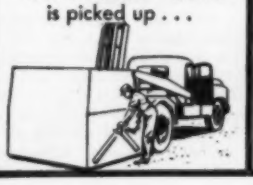

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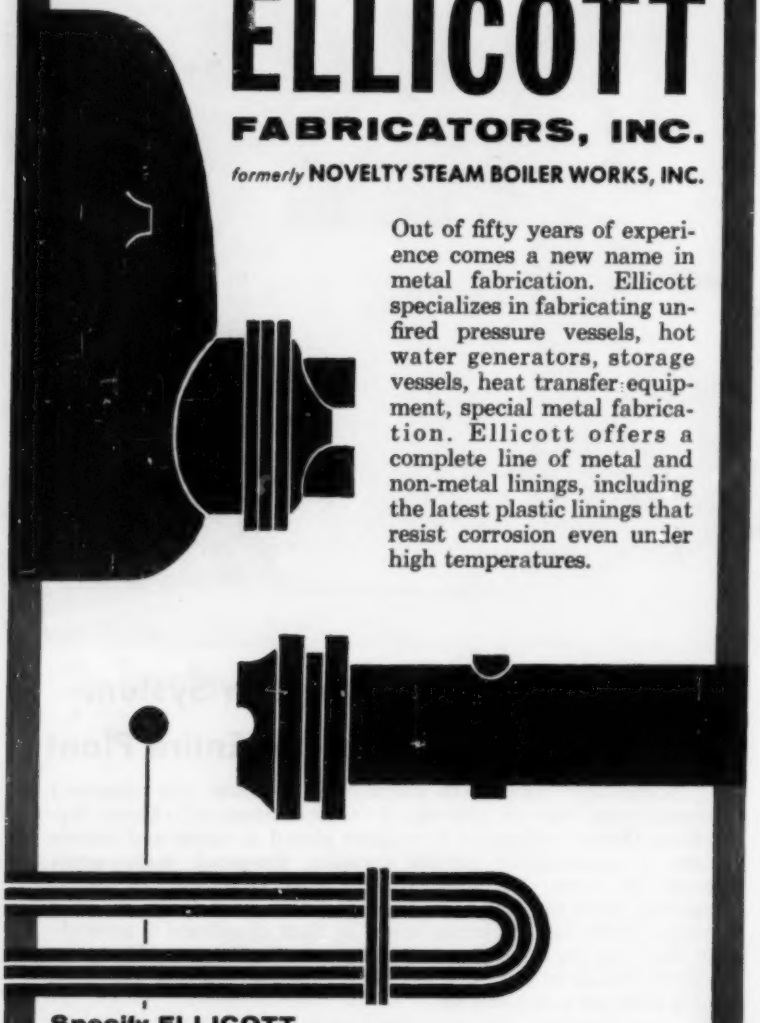

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Noted and quoted

(*Continued from page* 10)

but inevitably tends to move into other fields . . .

These controls come unwittingly, perhaps. They accompany the much-needed assistance that universities are receiving from the AEC to purchase the expensive machines needed for much of modern (especially high energy) physics and to assist in the development of educational patterns in nuclear sciences and technology.

Here again the separation of AEC functions and putting them where they belong would help to insure that the danger of a single control that tends to freeze patterns of education and fix research aims would be avoided.

The Atomic Energy Commission is the only agency of government which can subsidize the expensive facilities for high energy research. This has tended to result in an unhealthy concentration of such facilities in national laboratories and some other laboratories under more indirect AEC control.

Inevitably this causes a gravitation of the most competent physicists from widely scattered universities—where the students are—to the concentration points—where the facilities are.

This is an undesirable trend, for if it goes on, students will be forced to migrate to these establishments; there will be a gradual usurping of the function of the universities and ultimately the commission might have to grant degrees.

I have touched only on a few items and yet in every one of the cases I have mentioned, it must be admitted that the Commission has made at least a gesture of delegation to other groups.

The National Academy of Sciences has brought out a report on radiological hazards.

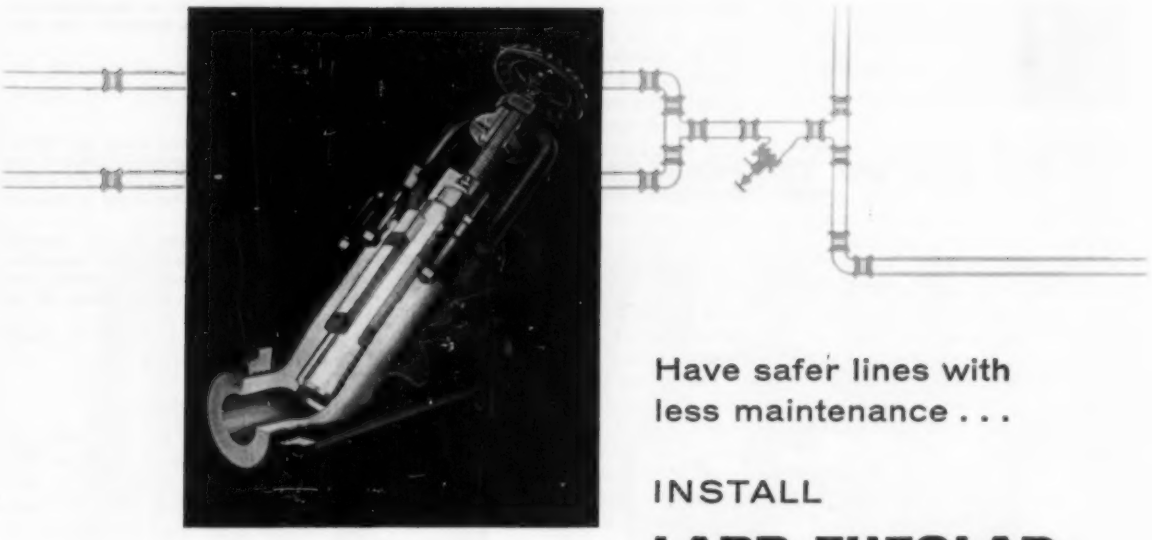
The universities have been assisted and brought into the national laboratories in various ways.

Industry—at least certain segments—has worked extensively for the AEC. And there are others.

The important thing is that here already is the experience which could be used to segment AEC's over-many functions—we have already a blue print for the delegation of functions so that AEC could get out of much of its business smoothly without interruption of the work if it can be allowed to relinquish control.

In summary, and with the utmost admiration for the extraordinary substantive accomplishments of the men who have worked for AEC, I would like to suggest:

- **That our congress moves positively to apportion out the operational and fiscal control of the AEC functions to the several appropriate permanent agencies of the government.**
- **That the high level of performance in urgent development which AEC has set need not be impaired by this action.**
- **And that, if this is done, the tremendous impact of nuclear energy on our whole society would not be subject to the inevitable hazards that accompany over-centralized control—over-centralized control which otherwise may have adverse effects on education, freedom, free, flexible and varied patterns, economy based on fair imaginative competition, and government based on an informed public.**



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WRITE for description and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 435 Chestnut St., Le Roy, N. Y.

letters to the editor

Saline Water Coverage Leaves Bitter Taste

The recent Saline Water Symposium (Washington, D. C., sponsored by the Office of Saline Water, Dept. of Inter. and Natl. Res. Council) was an excellent high level scientific affair, with good papers and important discussion both on the floor and in the corridors. I feel certain it greatly stimulated all those present, and that important advances will be made as the result of cross fertilization of ideas.

The conference also demonstrated that the technical and scientific program of the Office of Saline Water has been well conceived and executed. Two distinct types of novel distillation pilot plants (Hickman's and Badger's) are actually constructed and under test at a Harbor Island, North Carolina experimental facility. A large laboratory freezing unit is in operation at the Carrier Corporation in Syracuse. It is in my opinion a truly astounding advance to have engineers of the caliber of Badger seriously propose distillation process water costs of 25¢ per 1,000 gallons. This is within the ultimate target range. Of course Badger is probably optimistic; many of us think his figures are low, but everyone should consider that engineers are at least seriously debating about cost figures that are near the target.

The symposium also indicated that the program of the OSW has stimulated industrial interest and activity on desalinization. On the Pacific Coast a large utility is setting up a combined power generating and desalinization plant. At the other end of the picture, possibly the most important outcome of the OSW program may well be a real breakthrough in the way of a novel approach to this whole problem, conceived by one of the scientists who started work on the problem because of OSW stimulus.

And all of this has been done by OSW with a very modest budget—a few hundred thousand a year. Except for the pilot plants, which were naturally expensive (a couple of hundred thousand each—certainly not jet plane or missile money), the money was parcelled out a few thousand here and there.

Much of the above was completely missed or ignored by the lay press. Their reports completely and totally missed (1) the spirit, and (2) the significance of the meeting.

In my opinion the greatest misunderstanding arose from the attention given by the press to individuals and groups claiming even lower costs for demineralized water produced by their systems, but making such claims in the absence of supportive data. This situation was further compounded by the emphasis given by the press to the fact that these persons claiming such low figures had not been asked to participate in the symposium.

Granted that this meeting was on a subject of wide interest, it is deplorable that it had to be depicted as one around which such claims and counterclaims were associated.

One of the ill effects of this will be that the layman and the Congressmen cannot help but end up with the idea that the OSW program has been poorly carried out and has accomplished nothing. Agents of the USSR could not do a better job of misrepresentation of the facts in such a way as to degrade U.S. efforts. Thus, because of poor reporting, the next Congress will probably end up wrangling around about the OSW program, instead of supporting it adequately. A real success in this area, with proper publicity, would be a greater achievement than Sputnik, since all of the most critical political areas would be tremendously benefited by an increased supply of water.

Arthur Rose

State College, Pa.

Pollution Control Is Your Job

You have performed a real service in publishing the recent Engineers Joint Council policy statement on "Air Pollution and Its Control" (*CEP*, November, 1957, p. 146). Every chemical engineer should read this statement. This is the most reasonable and well-presented statement of the problem I have ever read. This is particularly true of the list of eleven principles, the last of which should be brought home to every engineer:

It is the responsibility of the engineering profession to participate vigorously in the field of air pollution control.

Two of the statements covering the engineer's function also bear repeating:

In view of air pollution causes and effects, and the technical nature of its control, the engineering profession is qualified and is duty bound to contribute substantially to the control of air pollution.

Engineers are involved, through research, development, design, construction, installation, operation, and maintenance, in activities that bring into being man-made sources of air pollution.

W. L. Faith

San Marino, California

Rifle Practice School

With reference to your editorial in the October issue of *CEP* (p. 459) proposing that the abandoned oil shale demonstration plant at Rifle, Colorado, be used as a training ground for future chemical engineers:

Knowing the Rifle installation intimately, I believe that certain of these facilities could be adapted to practice school training. The combination of housing arrangements with plant operation facilities certainly appears to make this a natural practice school. I am referring particularly to the pre-pilot plant laboratories and supporting analytical laboratories. Whether the experimental mine and the refinery would be adaptable, in view of their more specialized nature for oil shale processing, is less certain. However, these latter installations could, of course, be made available to industry for further oil shale experimentation.

It would be quite novel to utilize the development area and plant facilities of this vast new process industry—oil shale processing—for the training of future engineers for this industry, as well as for other process industry positions.

Charles H. Prien

Denver, Colorado

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marginal notes

Valuable Wall Chart

Trilinear Chart of Nuclides, 2d ed. W. H. Sullivan, Oak Ridge National Laboratory and Technical Information Service, Atomic Energy Commission (1957), 3 p. text; 6 p. charts, $2.00.

Reviewed by C. E. Stevenson, Atomic Energy Division, Phillips Petroleum Company, Idaho Falls, Idaho.

This publication represents a carefully conceived and well-executed effort to arrange logically and conveniently the available and commonly useful nuclear data on the over 1,200 isotopes of the chemical elements. Its form—that of a hexagonal pattern—is a little difficult to grasp initially, particularly for one who has been used to the conventional rectilinear arrangement of similar data presented on the Seaborg and General Electric charts. However, after a short period of use of the trilinear chart, its advantages become apparent relative to the other arrangements, and facility in its use is rapidly gained.

This reviewer cannot attempt to assay critically the data presented, but a hasty spot check of a few items in-

(*Continued on page 26*)

Now: the SBA-Kellogg way to

ACETYLENE

FROM NATURAL GAS OR NAPHTHA

Through special arrangement with Societe Belge de l'Azote (SBA), The M. W. Kellogg Company now can provide a continuous acetylene production process using naphtha or natural gas as feedstock. This improved process promises economies and results previously not obtainable.

Revolutionary Burner

The heart of this process is the SBA-developed burner. Easy to control, and requiring only minimum attention, it is stable and operates continuously—producing a constant yield. The formation of coke and tarry materials in the burner is virtually nonexistent. Any trace of these materials is automatically removed by special separation equipment.

Kellogg Cooperation

Through cooperative research and development by SBA and Kellogg, considerable engineering information has been developed on both the pyrolysis and purification systems. The results of this joint effort, available only from Kellogg, assure accurate and thoroughly reliable plant designs.

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Using naphtha feedstock, a wide range of ethylene to acetylene ratios may be achieved. This permits simultaneous production of ethylene and acetylene with great flexibility. In the case of natural gas feed, acetylene is the primary product—with negligible quantities of heavy impurities. If desired, the plant can be designed to operate on either feedstock.

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In the process train, the heavy acetylenes and hydrocarbons are removed first, leaving a stream containing acetylene and lighter materials. By using an SBA-developed ammonia absorption system, acetylene and ethylene are recovered from hydrogen and the other products of combustion, which in themselves are valuable by-products. The acetylene, 99.5% pure or higher, and ethylene are stripped from the ammonia. Ammonia makes this process safer than others because of its depressing effect on the explosibility of acetylene.

For More Information

Chemical companies and petroleum refiners interested in utilizing this advanced acetylene production process are invited to discuss their specific needs in person with The M. W. Kellogg Company. Please address inquiries to the Chemical Process Division.

CHEMICAL PROCESS DIVISION

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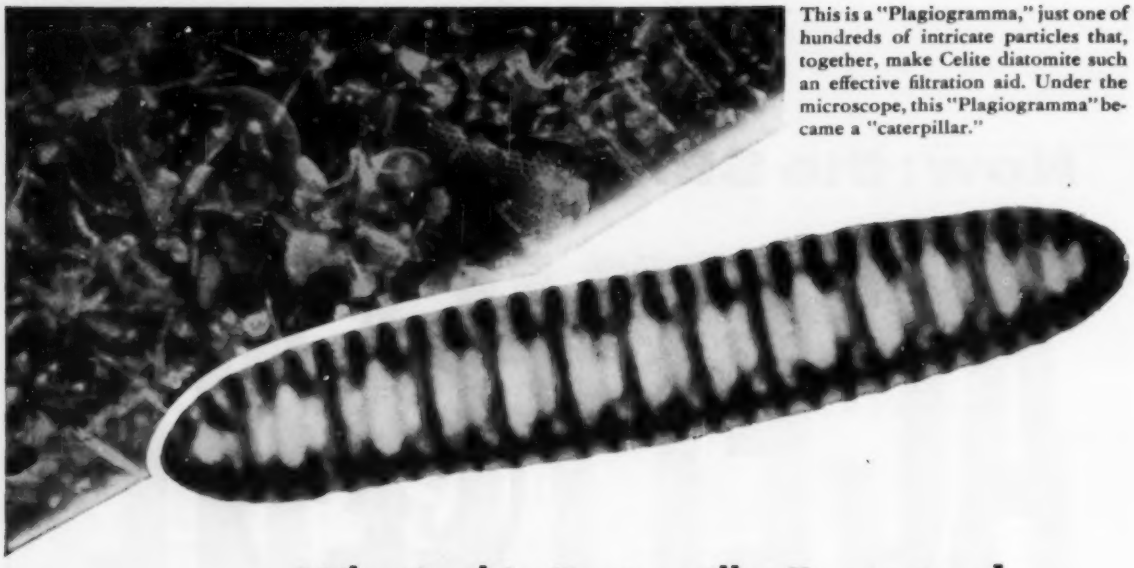

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*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

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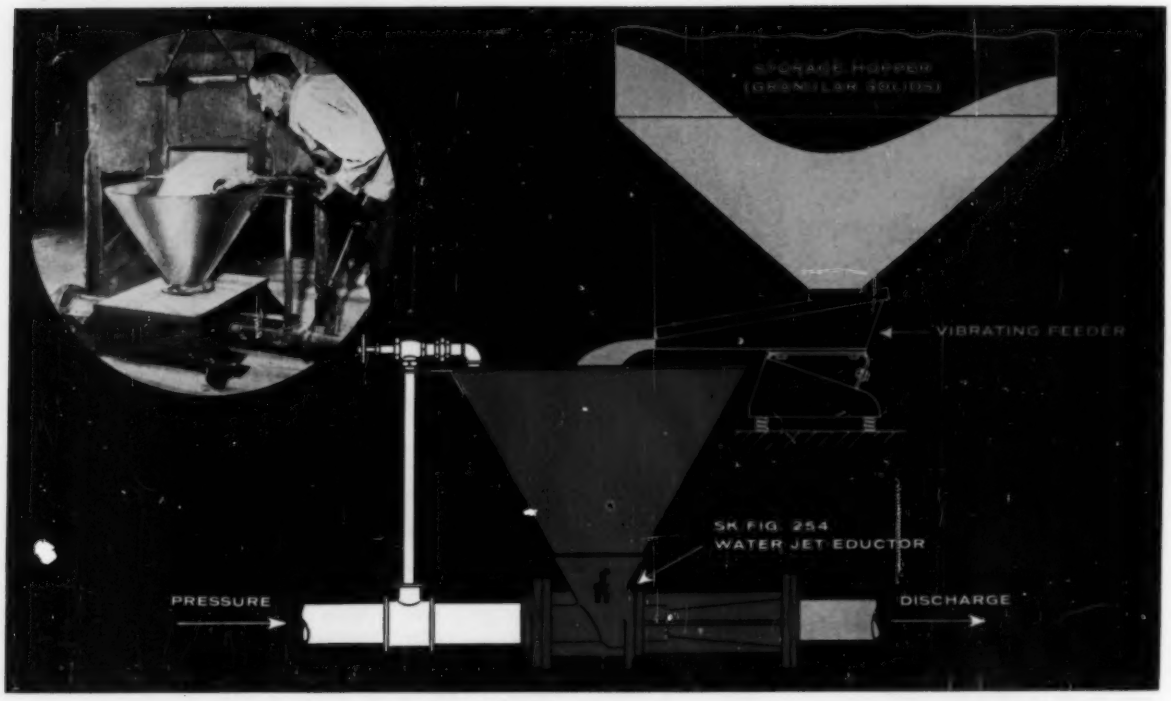
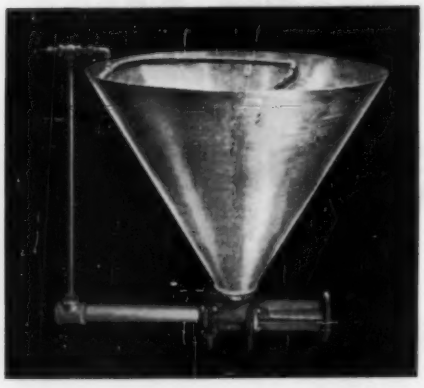


MIX SOLIDS WITH LIQUID, CONVEY SLURRIES

with this SK "Hopper Type" Water Jet Eductor

SK Fig. 254 Hopper Type Water Jet Eductor



SK's Hopper Type Eductor, shown above and at left, will mix solids with liquid and convey slurries conveniently and at low cost. See box below for types of granular solids currently being handled.

An inexpensive unit, this light-weight eductor is easy to install, simple in construction with no moving parts, requires little maintenance, and provides efficient service over long periods. In operation, pressure water, issuing through the nozzle, entrains granular solids from the hopper and discharges through discharge piping. Agitating jets keep material moving down into the eductor.

Used in the petroleum industry, in chemical processing and food processing plants, the hopper eductor has proved to be extremely satisfactory in handling the materials (bulk densities noted) listed below and others.

For full details on Hopper Type Eductors including sizes, capacities, ratios, water consumption, materials of construction, write to SK for Bulletin 2M.

SK HOPPER EDUCTORS ARE BEING USED CURRENTLY TO HANDLE THE FOLLOWING MATERIALS *(Approx. Bulk Densities Indicated in Parentheses)*

Borax (50-55)
Charcoal (18-28)
Diatomaceous Earth (10-20)
Lime, Pebble (56)
Lime, Powdered (32-40)
Mash (60-65)
Fly Ash (35-40)
Rosin (67)
Salt, Granulated (45-51)
Salt, Rock (70-80)
Sand, Damp (75-85)
Sand, Dry (90-100)
Sawdust, Dry (13)
Soda Ash, Light (20-35)
Sodium Nitrate, Dry (80)
Sulphur, Powdered (50-60)
Wheat (48)
Zinc Oxide, Powder, Dry (10-35)

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
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SCOPE

Supply, Training, Use of Engineers Continue as Major Issues

Quality rather than quantity, emphasis on graduate training aid, efforts of legislators to formulate schemes for channeling the technologists' efforts for greater defense effectiveness, and the pros and cons of federal aid to colleges and to students are seen as key factors in the great issue of the present time: what is our technologic effectiveness?

"We have always been short of high quality engineers and scientists," said retiring A.I.Ch.E. president J. Henry Rushton at the recent Annual Meeting of the Institute in Chicago.

"In this connection, we must realize that the key to our engineering and science future is in the university.

"As professional people," Rushton continued, "we have the obligation to work in any way we can to strengthen our educational system in terms of *quality*. Some universities have winning football teams as a result, I hear, of alumni presures. Cannot pressures also be put on University boards and State legislators for quality university instruction?" asked Rushton.

F. L. Hovde, president of Purdue, speaking with Rushton, advocated that "we should take steps at once to provide what is required to enable up to 20 per cent of our best graduating engineers to go on for their master's, and at least one-quarter of these to take their PhD's. The engineering societies must support a real drive for the improvement and expansion of our graduate schools of engineering at this time for two primary reasons: In almost every branch of technology our engineers are already working with problems on the fringes of present-day knowledge. Then, too, we are in a race for scientific and technical superiority with a formidable opponent. . . ."

FEDERAL AID TO EDUCATION . . . A COMPLEX COMPLEX

President Eisenhower's proposal for 10,000 undergraduate scholarships annually for the next four years (building up to a total of 40,000 in that period) is meeting mixed response. The proposal is so worded that scholarship preference would be given to those high school graduates already well-grounded in science and mathematics, which would seem to help increase the number of students in attendance in engineering schools.

Some, however, feel that aid in this direction is "putting the cart before the horse." One taking this view is Clark A. Dunn, v-p of the National Society of Professional Engineers in charge of educational matters. Dunn, acting as a spokesman for NSPE, feels that aid should be directed first toward improving and expanding the facilities and staffs of the universities and colleges, rather than opening the doors to larger numbers of students. Dunn also comes out for quality rather than

(*Continued on next page*)

For the Development of the Individual

"A.I.Ch.E. is dedicated to the development of the individual," said retiring president J. Henry Rushton at the recent Annual Meeting in Chicago. Rushton added at one point, "There is one lesson from the past which we must not fail to learn and remember: in every achievement it has been the ability of an individual person which has sparked the new idea, or the new application, or the new technique, and it is on the development of the individual that we must rely for good work in the future."

DuPont Patents Linear Polyethylene, Begins Licensing

A composition-of-matter patent covering linear polyethylenes has been assigned to DuPont by Arthur W. Larchar and Donald C. Pease. Patent number is 2,816,883, date of application August 2, 1951; date of issue December 17, 1957.

Under patent law, such a patent entitles DuPont to license all producers of the linear material, regardless of processes used for manufacture. DuPont has announced its intention to begin licensing at once. If the validity of the patent is questioned, it would come about through refusal of producer to accept licensing, and legal action by DuPont. Precedent in such a case might be the I.C.I. patent on non-linear polyethylenes, held successfully for its full legal life.

Another NDRC or OSRD Not in Works

The Administration does not favor resumption of the type of scientific R & D direction and coordination employed during World War II. This is the opinion of one of the former top leaders in NDRC and OSRD, executive agencies established by F.D.R.

Grace—50 Million More Pounds of Polyethylene

U.S. productive capacity of high density polyethylene has jumped upward by 50 million lb./yr. with the successful start-up of Grace's Baton Rouge, La., plant, said to be the largest single unit now in operation.

SCOPE

quantity. He praises the plan's features for additional graduate fellowships, supporting funds for graduate schools, and the increase in appropriations provided for the National Science Foundation.

EJC's EMC OBJECTS

The Engineering Manpower Commission, on the other hand, objects to Federal aid to education on a basis of broad principle. In an open letter, dated December 17, to James R. Killian, Jr., special assistant to the President for Science and Technology, EMC's chairman G. E. Arnold said: "We find little enthusiasm in the engineering community for the launching of a Federal undergraduate scholarship program. Industrial and private attention to financial support of higher education is at an all-time high, and with the increased participation of these sources it would indeed be regrettable to discourage them and reverse this trend. This will inevitably occur should the Federal Government start allocating funds for the same purposes."

Arnold's letter, which incidentally was signed also by H. A. Meyerhoff, executive director of the Scientific Manpower Commission, goes on to "favor programs directed toward increasing the quality of graduate studies in engineering and science."

The problem of diversion of young engineers and scientists, "many with impressive educational and professional backgrounds," from technical pursuits by "military procurement laws and regulations" was commented upon as follows:

"We strongly recommend . . .

1. The suspension of induction for military service of engineers and scientists . . .

2. The release from the military of engineers and scientists not being utilized in their professional capacities, if they request such release.

3. Revision of ROTC assignment procedures to give priority for brief active duty training periods to engineering and scientific graduates . . . .

4. Development of a truly Professional Service for career engineers and scientists in the uniformed military services . . ."

EMC then finally maintains, in the Arnold letter, that "the country has now the engineers and scientists necessary to accomplish the immediate task before us and we need only to develop and implement policies and plans to properly administer their talents."

TECHNOLOGISTS' EFFORTS TO BE RIGHTLY DIRECTED?

With Congress convened and Washington alive with concern regarding how best to get our nation's scientific and engineering strength out in front again, many plans are being discussed that have to do with making certain that our scientists and engineers are employed in such manners, on such projects, and in such strength as to bring about results in fields deemed necessary for our national security.

Senator Styles Bridges (*N.H.*) is ranking Republican in the U.S. Senate for the newly convened Congress. How the Senator feels with regard to the best employment of scientists and engineers is no doubt of some import. In the October 19 issue of *Human Events*, a publication issued by Frank C. Hanighen of Washington, D. C., an article by Senator Bridges appears which contains, in substance, the following:

. . . "Since World War II we have made the fundamental mistake of allowing many of our scientific programs to be dictated by the wishes and special interests of the scientific hierarchy. *We have allowed the experts to be on 'top' and have not kept them on 'tap' as they should be.*"

Senator Bridges then goes on to review the cases of the development of the hydrogen bomb and the nuclear-powered submarine as exemplifying his point. He summarizes his belief that scientists have been too influential, and reaches a preliminary con-

Lower Discount Rate Helpful, Rigidity of Labor Costs Dangerous

The recent action of the Federal Reserve in lowering the discount rate on money available to banks from 3½ to 3% will prevent the present downturn of business from becoming cumulative, according to former Reserve chairman Marriner C. Eccles, speaking before the recent Annual Meeting of A.I.Ch.E. in Chicago. Rigidities in the economy, however, will make unlikely any immediate reduction in the cost of living or in prices generally. As a primary factor in this "rigidity," Eccles pinpointed the increasing share of the national income which has, in recent years, been secured by organized labor. According to a recent survey by the Twentieth Century Fund, said Eccles, total wages and salaries were 50% of the national income in 1929 and 73% of it in 1955, whereas dividends decreased over the same period from 5.8 to 3.9% of that income. "Unfortunately," he went on, "the economic facts of life are such that all the economy has to divide is the goods and services which it is able to *produce*—and not the amount of money it could *create*, which is, of course, limitless."

The speaker took issue with a recent Presidential statement that an adequate defense was more important than a balanced budget. A deficit should not be permitted solely for the purpose of maintaining an adequate defense program, if the effect of so doing is inflationary. It would, in his opinion, be more in accord with a stable money policy to increase taxes or to reduce other expenditures.

Turning from the domestic scene, Eccles voiced criticism of our recent policy vis-a-vis the Communist world. The more than $60 billion we have spent on economic and military aid have, in his view, only contributed to a deterioration in our world position, and have gained us neither friends nor influence. Eccles called for an end to our policy of refusal to recognize Red China, and advocated a stronger effort to change our attitude toward the Communist world, including increasing person-to-person contacts with the people behind the Iron and Bamboo Curtains.

Medal and Award for Scientific Contribution?

"A Congressional Medal for Science" will be proposed at the present session of Congress by Rep. James C. Auchincloss (N.J.) according to the Congressman. Aimed at stimulating significant scientific developments, the medal, accompanied by a $50,000 tax-free cash award, would be awarded by a House-Senate committee, after screening candidates nominated by the President, Vice-President, cabinet officers, and members of Congress.

clusion that it doesn't take a scientist to provide the answers to questions about national policy with respect to scientific advances relative to the Soviets.

"It appears as though the 'experts' have had their day and it is time to return to the people the people's business," continues the Senator.

"The average American wants to stay ahead of the Soviet in weapons. The only way to do this is to work at it.

"It is now up to the President, or, if he does not, to the Congress, to begin to assume the responsibility for the direction of our scientific effort. This is a job for our elected officials and not for our PhD's.

"The time has come, not to ask our scientists what to do, but to tell them what must be done. The entire history of scientific development indicates that technological breakthroughs are in direct correlation to the amount of time and money expended.

"We need a ballistic missiles coordinator. Not a scientist, but an administrator who will be given the job to do and an overriding priority in manpower, material, and money to get the job done. Any programs now in existence or contemplated which interfere with the rapid completion of this task must be curtailed or abolished.

"Scientific groups must be organized under the leadership of this administrator and all different approaches to the solution of the problems must be pursued simultaneously, as was done in the case of the atomic bomb. In this way we can compress the normal progress of years into months. Political partisanship has no place in this program. Money is no object when national security is at stake, though it must be fairly stated that if many projects now dissipating our effort were abolished, the balance sheet would be on the plus side.

"The type of program which I am suggesting is not a regimentation of American science. It is merely a demand—which will be answered enthusiastically by our physicists, chemists, and engineers—that in our country's obvious hour of need they lay aside their preferable pursuits and produce the necessary instruments to protect us all. This is nothing more or less than other vast segments of our society are called upon to do constantly."

Senator Bridges then concludes: "This, therefore, is the greatest political decision of our time. Are we going to continue to allow the 'experts' to stay on 'top,' or are we going to insist that their specialized talents be 'tapped' by the people of the United States, so that this country will survive?"

Process Control Group Surveys Ch.E. Education

More and more firms are setting up special units to study application of advanced control systems theories, but are hindered by extreme shortage of systems-trained personnel with chemical process backgrounds. Questionnaires sent Ch.E. educators by A.I.Ch.E.'s Process Control Educational Subcommittee found the training problem one which requires decisions, implementation.

"The colleges," states the group's preliminary report, "face a tremendous problem in presenting such courses because of the following: tight present curriculum, difficulty in setting proper mathematical level for presentation, shortage of instructors, lack of computing and demonstration equipment, and need for problems and examples of applications in the chemical processing field."

The subcommittee is made up of both educators and industry specialists. *CEP* will cover the report in detail next month.

Polypropylene Race—Hercules, Montecatini on Stream

Montecatini of Milan, Italy, has announced current production at their Ferrara plant as being at the rate of 15 million lb./yr. Meanwhile, Hercules Powder, first into production on this side of the water, says it will be turning out 20 million lb./yr. of polypropylene in early 1958. Price for Hercules' initial distribution: 65¢/lb.; Montecatini's is yet to be set on basis of customs rulings. Present price for deliveries in Italy is equivalent to 61¢. Montecatini launched, at the time of the Chem Show, a U.S. sales campaign with evaluation samples. High purity propylene for Hercules' Parlin, N.J., plant will come from a new petrochemical plant at the Marcus Hook, Pa., refinery of Sinclair Refining. Other U.S. companies known to be considering polypropylene are DuPont and Standard of Indiana. In Europe, Farbwerke Hoechst, Frankfurt, Germany, is said to be ready with a commercial-scale plant—estimated capacity between 15 and 20 million lb./yr.

As Others See Us?

"For instance, right now, do you think the Russians are fooling around with a regional get-together of metallurgical engineers?"
Drawing by Dedini, © 1957 The New Yorker Magazine, Inc.

SCOPE

Wilson Calls for Two-Way Responsibility

Management responsibility for the welfare and contentment of professional employees is not a one-way street, proposed Robert E. Wilson, Chairman of the Board of Standard Oil (Indiana), at A.I.Ch.E.'s recent Chicago Annual Meeting. Good working conditions, adequate compensation, freedom from menial or excessively routine tasks—all these things are deserved by the average professional.

On the other hand, engineers and scientists in the employ of a firm, said Wilson, should recognize their responsibilities to management. Among the responsibilities cited by Wilson was the realization, on the scientists' part, that their company is engaged in a competitive struggle. Particularly if involved in research, they may well spot new trends sooner than management.

Technical Aid to Underdeveloped Countries

The number of American technicians working on technical assistance projects in underdeveloped countries is expected to be cut over the next two years, according to present Administration plans. At a recent A.I.Ch.E. panel discussion on "Engineers Overseas—an Important Phase of a Post-war Trend" the demand for the technical know-how of the United States was predicted to be a continuing one. The present difficulty in getting highly trained personnel capable of operating effectively in other lands is a problem which would be accentuated, rather than eased, by the new policy. This is a problem which affects the chemical engineer, since more members of the profession than ever, with other specialized training, will be needed if and when the Administration's policy shifts back to more aid instead of less.

The thirst for a better standard of living on the part of the peoples of Asia, Africa, and Latin America will for at least another generation cause a tremendous demand for rapid industrialization of their countries to make better use of their resources. This was a conclusion reached by the panelists, who represented industry in the U.S. and Italy, and included a staff member of the Government's International Cooperation Administration. From a report issued early this month by the State Department, entitled "Study on Soviet Economic Aid Campaign in Mid-east and Orient," it is apparent that if U.S. technical aid is reduced, it will be replaced by aid from behind the Iron Curtain.

To do a really effective job overseas requires technical personnel with specialized training, according to the panel. One of the prime assets in the eyes of the people being aided is experience—ten years or more, with a few grey hairs to show a stint in the school of hard knocks. Another quality needed is the ability to understand and to communicate with the people being aided.

Most of our technicians abroad in ICA service are not fluent in the languages of the countries served, reported the panel. One reason is that with extreme mobility usually being the case, the technologist finds it well-nigh impossible to speak and read the languages of all the places he visits. On the other hand, to continue indefinitely supplying personnel who have not gone through the mental gymnastics of learning at least one other language was looked upon as an indication of an immature approach to the long-range problem. Recommended additional tongues for those who wish to prepare for the future: first, Spanish, then Russian or Chinese, then French, and last in the recommended series, German.

One kind of preparation not recommended is the acquisition of a vast amount of the past history of the country to be aided. An understanding of the people and the problems of the day, rather than an attempt to supply the "answers" from yesteryear, was the advice of the panel.

Since the high demand for their services still continues, technologists interested in aid work abroad should take the panel's advice to begin preparation now. They will then be ready when and if Government's foreign aid policy shifts again.

Panelists were: John P. Ferris, ICA; Vittorio de Nora, Oronzio de Nora, Impianti Elettrochimici; R. E. Hope, Davison Chemical; J. J. Prichett, Hilton-Davis Chemical; G. B. McGuire, Esso R & E.

Engineering Center Fund Campaign Plans

"The engineer needs an adequate platform from which to expound his efforts as a creator of economic and social values. The new United Engineering Center, a focus of life for sixteen national engineering societies, will provide the platform and the symbol," says C. F. Kettering, Chairman, United Engineering Center Building Fund, Member-Gifts Campaign.

Overall goal of the fund raising drive is $10 million; $5 million is expected from industry, $2 million from present UET reserves, and $3 million from members of the Founder Societies. AIChE quota is $300,000, compared to $800,000 for ASCE, $500,000 for AIME, $800,000 for ASME, and $900,000 for AIEE.

Leadership of the Member-Gifts Campaign, under the honorary chairmanship of Kettering, is presently as follows: Honorary Vice-Chairmen are: Holbrook of AIChE, Howson of ASCE, Holt of ASME, and Barrett of AIEE. Serving under General Campaign Chairman Dougherty are: Co-Chairmen Whitman and Kirkpatrick of AIChE, Needles of ASCE, Ryan of ASME, and Goldsmith of AIEE. Treasurer is Molineaux, Public Relations Chief is Jessup, and Executive Director is Davies.

Solid Boron-Carbon-Hydrogen Fuels May Have Exciting Future

Far-reaching changes in rocket and other engine design may be the result of new researches by Callery Chemical into a whole gamut of solid propellants. Ram-jets containing only solid fuels, or solid-liquid engines in which only the oxidizing agent will have to be metered and fed are only two of the most obvious possibilities. First goal of Callery's program is production in solid form of "HiCal," a boron-carbon-hydrogen compound which will be available in quantity when the $38 million Muskogee, Oklahoma, plant under construction by Callery for the Navy goes on stream.

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U.S.I. CHEMICAL NEWS

January ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

New Non-Narcotic Drug Has Potency of Codeine

A new analgesic drug — dextro propoxyphene — is now on the market. It is reported to be clinically equivalent to codeine in intensity of analgesia, and in onset and duration of action. At the same time, side effects are said to be fewer. No toxic effects on liver, blood, brain, kidneys or other organs have been demonstrated. And, after several years of exhaustive tests, government authorities have classified the material as non-narcotic drug — producing no euphoria, tolerance or physical dependence.

Dextro propoxyphene hydrochloride also acts as an antipyretic, reducing fever, and as an anti-inflammatory, combatting local hyperemia and swelling. Clinical usefulness is expanded by combining this amino ester with other ingredients such as acetophenetidin, caffeine and acetylsalicylic acid.

Although chemically different from all other analgesics, it is believed to act in the same manner as meperidine, codeine and morphine — that is by raising the pain perception threshold through depression of the sensory area of the brain.

Riboflavin Overcomes Boron's Growth Inhibition

A European microbiologist has found that riboflavin overcomes the growth inhibition of test organisms caused by boron. None of the other B vitamins have this effect.

These findings may have some importance in areas such as the American southwest where the soil has a high boron content. Boron is taken from the soil by plants which are consumed by livestock, and the element may tend to interfere with the vitamin metabolism of these animals.

Viscosity Changes May Be Clue to Chemical Activity In Complete Ester Mixtures

Investigations reported in the literature have revealed that the viscosity of true ester mixtures of ethyl alcohol, acetic acid, ethyl acetate and water changes steadily on standing. The conclusion is that association, dissociation, hydrate and solvate formation are taking place, and that viscosity determinations may therefore be useful in studying the progress of such activity.

Viscosity has long been employed to determine the extent of molecular association, and the degree of solvate and hydrate formation in liquid mixtures at some particular moment. It has never been used, however, to examine changes over time intervals.

In the study reported, relative viscosity measurements were made on complete ester mixtures after 2, 9, 21, 51, and 84 days. Viscosities changed steadily, but tended to reach an equilibrium value. The investigators feel that this time factor must be properly evaluated before further study of hydrates, solvates and association values is made.

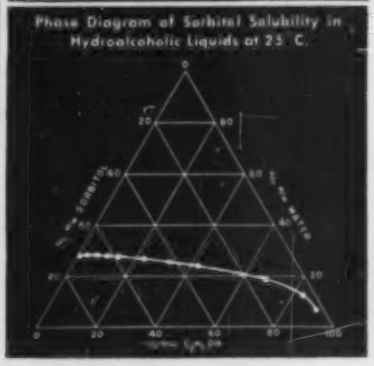
Sorbitol Solubility Measured In Elixirs and Syrups Containing Alcohol and Water

Studies Reveal Solubility of Sorbitol in Water-Ethanol Mixes

The hexahydric alcohol, sorbitol, widely used in liquid pharmaceutical preparations, has now been thoroughly studied in water-ethyl alcohol systems to determine extent of solubility. The table and phase diagram below show the results of this investigation. They indicate that a sizable amount of sorbitol can be incorporated into most pharmaceutical systems of hydroalcoholic character—about 65% by weight in 20% alcohol, about 50% by weight in 50% alcohol, about 14% by weight in 80% alcohol, and so on.

SOLUBILITY OF SORBITOL IN HYDROALCOHOLIC LIQUIDS AT 25°C.

Sample	% v/v C_2H_5OH	Sp. Gr. Saturated Solution	% w/w Sorbitol	% w/v Sorbitol
1	0	1.308	71.90	94.05
2	11.33	1.284	68.62	88.22
3	20.73	1.265	66.02	83.50
4	33.86	1.233	62.38	76.92
5	41.47	1.200	57.98	69.59
6	52.80	1.152	50.45	58.12
7	62.33	1.089	42.70	46.49
8	71.56	1.026	33.84	34.72
9	82.20	0.9123	13.64	12.42
10	90.94	0.8433	3.41	2.88
11	95.41	0.8177	1.92	1.57



It has been well known for some time that while sorbitol is highly soluble in water alone, the solubility tends to decrease when ethyl alcohol is added. Since sorbitol acts as a vehicle in many cough syrups, elixirs and vitamin preparations which contain alcohol, the extent of this decrease has become a question of great interest to the industry. Until this study was made, no data on the subject had been available.

Properties which have made sorbitol useful to the food and drug industries include sweet

MORE

Polyethylene Use Is Extended by New Compounding Process

A process, whereby polyethylene is combined with 50% or more of carbon black to create compositions which remain flexible even at extremely low temperatures, has been developed by Godfrey L. Cabot, Inc.

These compositions are said to be strong enough for structural use where rigidity and pressure resistance are important. Creep and fracture are reported to be minimum.

A variety of molded and extruded parts have been fabricated successfully from the new material. Pipe, for example, has exhibited resistance to stress cracking, improved high temperature behavior, virtual elimination of plastic flow, and improved resistance to deterioration by solvents and oils. Lab tests have indicated that burst strength is doubled. The same applies to wire and cable cover.

Cabot feels that the development makes possible a new range of usefulness for polyethylene. They will not manufacture these compositions themselves but will supply the carbon black and their process knowledge to polyethylene producers such as U.S.I.

New Ceramic Textiles Withstand Heat of 2000°F

Aluminum silicate fibers have now been converted into a variety of textile forms for high temperature applications.

Fabrics weighing from 15 to 74 ounces per square yard are said to have excellent insulating properties due to low thermal conductivity, high yarn bulk, natural resilience and small fiber diameter. Stainless steel or nickel-chrome alloy wire is inserted into some constructions for greater tensile strength in the 1,000 to 2,000°F range.

Rovings and yarns in sizes from 600 to 1,000 yards per pound are useful as insulation for electric circuits that must withstand very high temperatures.

Rope from ¼ to ¾ inch in diameter is being applied as insulation and packing in various metallurgical refining processes.

Other suggested uses for cloth and tape include filter media, gaskets, heat and flame barriers and membranes, conveyor belts, protective clothing and insulating blankets.

January ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Sorbitol

taste (about 60% as sweet as sucrose), high viscosity in water solution, lack of reaction with medicinal or other ingredients, ability to inhibit crystallization, and humectant action. It is often used in combination with glycols, glycerin and sugar syrup as well as ethyl alcohol.

Paper Can Now Be Made From New Acrylic Fibers

A new type of paper has been developed which will be of special interest to the laminating industry and for electrical uses, chemical filtration, chromatography and many other applications.

It is made of a new acrylic fiber, is binder-free, and can be produced on conventional machinery. Production quantities are expected in the near future.

First Caustic Soda Plant Established in Ceylon

May Also Produce Bromine

The first caustic soda factory in Ceylon, built by a government-sponsored corporation, is expected to begin operations this month. It is equipped with 56 electrolytic diaphragm cells having a daily output capacity of five tons of caustic soda.

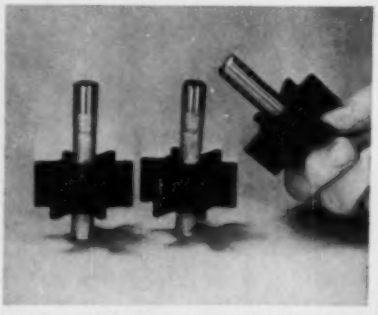
Bromine may also be produced. In the manufacture of common salt from sea water, a nearby factory discards thousands of tons of bromine-rich waste liquors. Engineers are considering the production of high-grade elemental bromine from these wastes.

Titanium Impeller Shaft Solves Corrosion Problem In Pumping Ferric Chloride

Impeller shafts of commercially pure titanium are now being used in pumps to carry ferric chloride solutions. They are reported to yield at least 320 hours of pump service without leakage. Materials tried previously — special ferrous and non-ferrous alloys, and platings of nickel, silver and rhodium — have given maximum service life of 45 minutes due to corrosion of the shaft and loss of tight seal.

The titanium impeller shaft was originally incorporated into a prototype pump unit and tested to solve a particular problem in the etching of printed circuits. It was found that the prototype unit would run for at least 321 hours without damage. And the initial cost of the special shaft was offset in the first 90 minutes of operation. The pump is now a regular production item.

Mallory-Sharon Titanium Corp., now affiliated with U.S.I. in the new Mallory-Sharon Metals Corp., participated in the original test runs by supplying the titanium.



At left are two impeller shafts which failed after 45 minutes of pumping ferrous chloride. Both are made of premium metals, one ferrous, one non-ferrous. At right is a titanium impeller shaft showing no sign of corrosion after two months in the same service.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Research reactors now in operation or being built in the U.S. are reviewed in a new booklet which can be purchased from gov't. Data and illustrations on over 30 reactors are included. **No. 1311**

A marking pen consisting of a heavy-wall polyethylene squeeze tube with felt writing point, filled with ink that writes on porous and non-porous surfaces, is now on the market. It is low-cost, disposable, comes in 7 colors. **No. 1312**

New fuel oil additives to prohibit gum formation in oil stocks are fatty amine derivatives claimed to also protect against color degradation and to improve filterability. **No. 1313**

Over 1,500 assayed biochemical compounds, along with their full specifications, are listed in a new reference guide for workers in bacteriological, nutritional, biological and microbiological research. Price list included. **No. 1314**

Three new hydrazine derivatives are available in lab quantities. Hydrazine dihydrochloride is suggested as a chlorine scavenger for hydrochloric acid, hydrazodicarbonamide as a chemical intermediate, monohydrazinium phosphate as an oxygen scavenger for boiler feed water. **No. 1315**

Analytical microscopy relative to foods, drugs, spices, water is discussed in a new book which can be purchased. The 215-page book describes preparation of materials for examination, gives examples of problem solutions. **No. 1316**

Isocinchomeronic acid, suggested intermediate for drugs, insecticides, polymers, dyes, is now offered commercially. Its ring-nitrogen is said to offer possible increased dye receptivity in polymer applications. **No. 1317**

Remote evaporation and drying by infrared radiation is now possible with a new heater for lab and semi-industrial use. Placed above a flat crucible, the radiator is claimed to evaporate without boiling or loss of material. **No. 1318**

New acid inhibitor has been developed which, it is said, can be used on high carbon steel without etching. It is used at about 0.2% by volume, added to non-oxidizing acids such as sulfuric, hydrochloric, hydrofluoric, oxalic. **No. 1319**

Molded polyethylene waste and drainage systems are now on the market. According to the manufacturer, traps, pipe, joints, fittings will withstand intermittent flushing with boiling water without deterioration or loss of form. **No. 1320**

PRODUCTS OF U.S.I.

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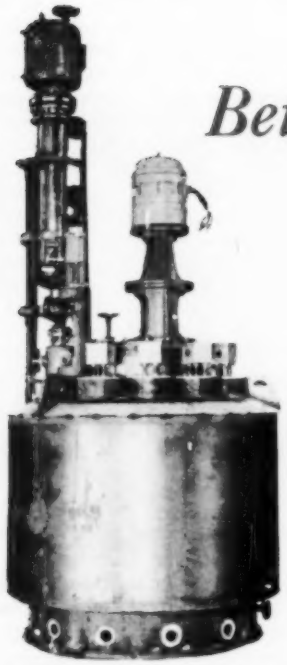

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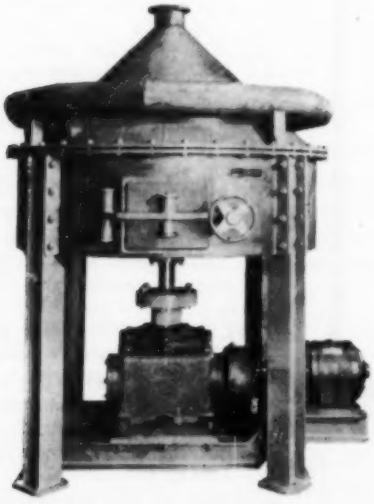

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BULLETIN No. 31

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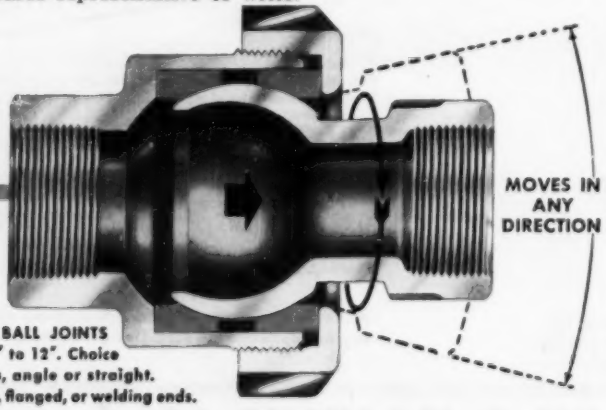
New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:



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Marginal notes

(*Continued from page* 14)

dicated that they were up to date and reliable. It appears that every reasonable effort has been made to incorporate all possible pertinent and useful data in a minimum of space, and to assign quantitative significance to the data. The data presented are of real value to the engineer concerned with use of irradiation, nuclear fuel reprocessing, radiochemistry, tracer applications, reactor design, and many other fields of nuclear science.

The chart is presented in the form of six folded sections contained in a binder. Although some may use it in this fashion, it is felt that the interrelationships of the isotopes can be conveniently visualized only when the data are displayed as a wall chart. The six sections may be glued together to form a narrow and inconveniently long chart (17 ft. overall).

Introduction to the Hydrocarbon Families

Properties of Petroleum Reservoir Fluids, Emil J. Burcik, John Wiley & Sons, Inc., 190 p., $7.50.

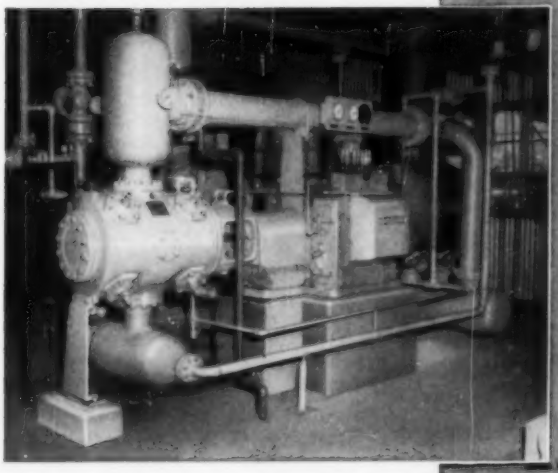
Reviewed by Donald L. Katz, University of Michigan, Ann Arbor, Michigan.

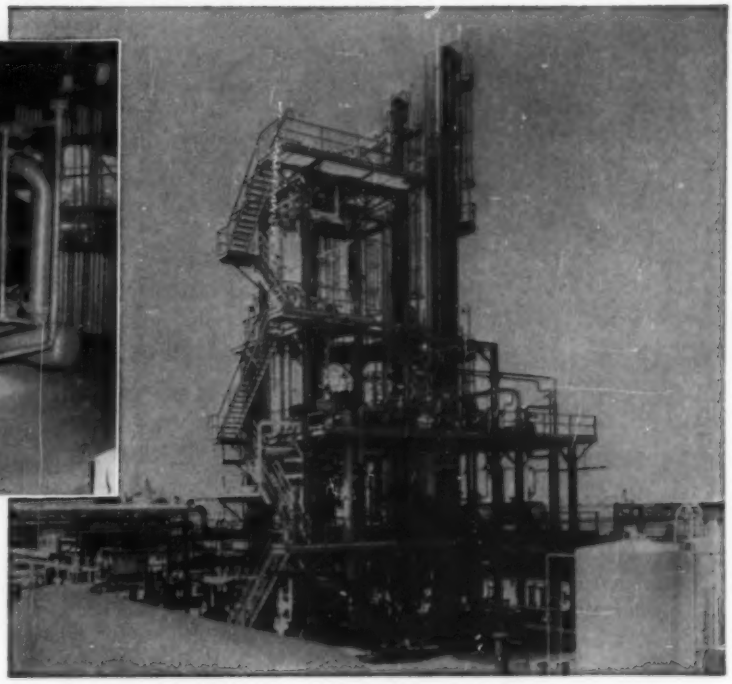
Properties of natural gas, crude oil, and solutions thereof are presented in a form suitable for presentation to beginning petroleum engineering students. The book starts with the elementary organic and physical chemistry required to understand the hydrocarbon families which compose petroleum and the behavior of gases. Quantitative charts for presenting the deviation of natural gases from ideal gas laws are included. The subject of phase behavior including the equilibrium constants is treated both qualitatively and quantitatively. Methods for predicting the densities and viscosities of both liquid and gas phases are presented. The solubility of gases in crude oils and in water is treated.

In the final chapter an application is given of solubility and shrinkage phenomena to material balance calculations for constant volume reservoirs. The material balance equation is combined with the flow equation and relative permeabilities to predict reservoir pressures and gas-oil ratios for the pressure depletion of a reservoir.

This is an interesting book. Those who work the problems at the end of the chapters in addition to reading the text should have a rather clear elemental understanding of the behavior of petroleum reservoir fluids.

Frontier Chemical uses I-R compressors for new chlorohydrocarbon process





Above, one of two 200-hp Ingersoll-Rand motor-driven HHE ammonia-refrigerant compressors in the chlorohydrocarbon unit at Frontier Chemical Company, Wichita.

Frontier Chemical Company's new chlorohydrocarbon plant at Wichita, Kansas, is now on stream helping to meet the booming demand for such products.

Designed by Frontier engineers and C. F. Braun, and built by J. F. Pritchard & Co., the new plant features reactor equipment different from any used before in this process. Reaction is at moderately high temperature, and the feed preparation step includes fractionation at super-low temperature rather than the common oil-absorption method.

The Front End of the system employs two 200-hp Ingersoll-Rand HHE ammonia refrigerant compressors. These horizontal electric-driven units are two-stage, the low-pressure cylinders being completely encased with insulation and coated with mastic.

Other I-R Process Equipment at the plant includes a non-lubricated instrument air compressor, a two-stage ethylene compressor, and an I-R vacuum pump which was purchased second-hand six years ago and since has given absolutely trouble-free operation. There are also a number of I-R centrifugal pumps.

Repeat Orders...There are a number of varied I-R compressors now on order for the plant, including a new-type four-stage methane compressor. Repeat orders on process equipment such as this are common at Ingersoll-Rand, where the world's most comprehensive compressor experience... and the most process experience... result in the best unit for any service.

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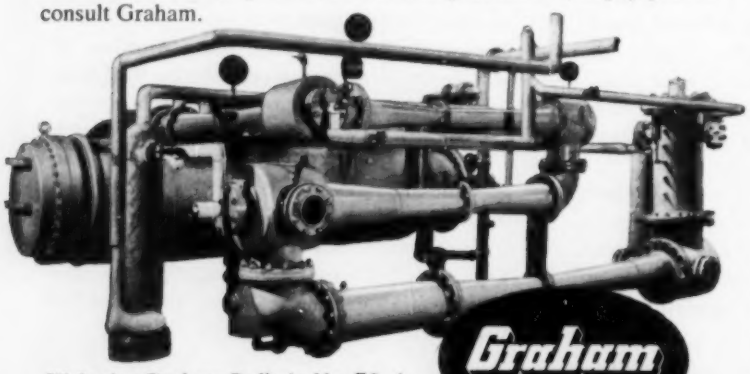

Write for Graham Bulletin No. 70-A.

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415 LEXINGTON AVENUE, NEW YORK 17, N. Y.
Offices in principal cities and Canada

about our authors

Reporting on the development of a new process for making acetylene this month are **George A. Akin,** research associate in the laboratories of Tennessee Eastman; **Toy F. Reid,** head of the petrochemicals pilot plant with Tennessee Eastman and immediate past chairman of the East Tennessee Local Section of A.I.Ch.E.; and **Robert J. Schrader,** now superintendent of polyethylene plant with Texas Eastman. Developed along with the Eastman process was equipment permitting operation at temperatures as high as 2,500° C.

Akin

West

Andrews

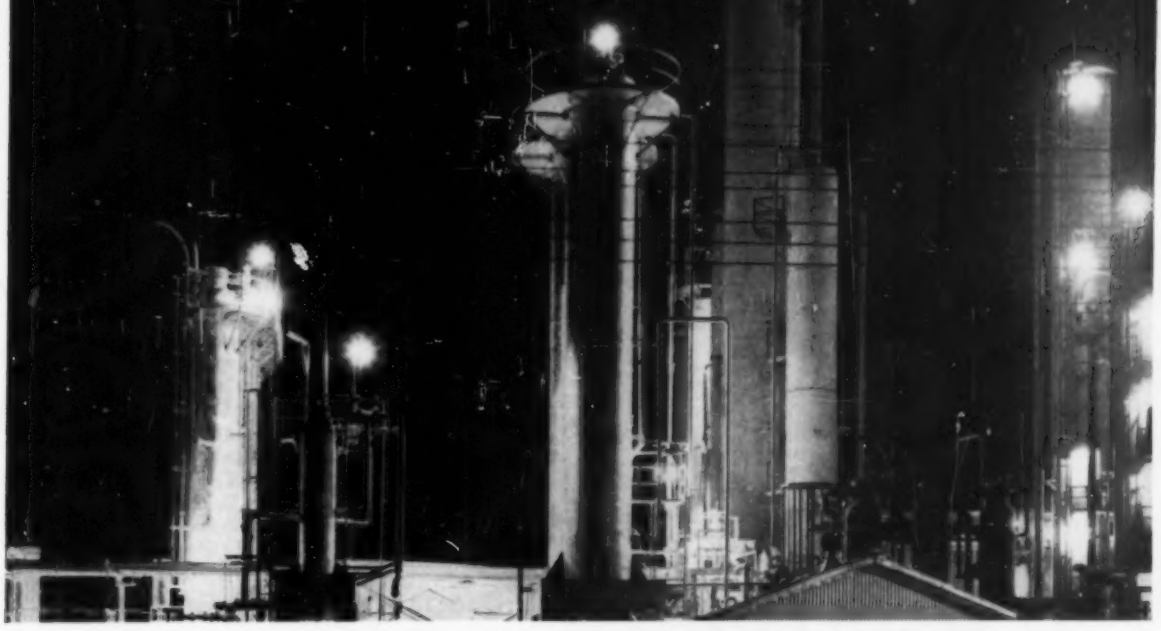
A. S. West, process design group leader, and **C. J. Prizer,** process development group leader with Rohm & Haas' Semi-Works Department, are in a good position to give a first-hand account of problems encountered in design, organization, and operation of a multi-purpose organic chemical pilot plant department, of which the toxic area described in this issue is a part. Prizer's most recent interests have been in processes for manufacture of ion exchange resins, plastic molding powders, and polymeric oil additives. West, who has been working with high pressure processes, is vice-chairman of A.I.Ch.E. Membership Committee for 1958.

Plant manager **H. J. Andrews** (Lithium Extraction from Run-of-Mine Spodumene Ore) has been with Lithium Corporation of America since 1951, was part of the team which designed, constructed, and now operates the lithium plant described. LCA's expansion gave the team the opportunity to put its long-thought-out design ideas to work and to verify its faith in the future of the still-growing lithium industry.

Strong advocates of increased international understanding and cooperation in research are Battelle's **Frank C. Croxton** and **M. A. W. Barnick.** Croxton, who went to Battelle in 1939 from the research staff of Standard of Indiana, became technical director in 1947, has had the satisfaction of seeing Battelle's European research activities grow to three times what they were in the U. S. when he joined the

(*Continued on page* 30)

PROCESS SUPER DRYING SIMPLIFIED



MHI CALCIUM HYDRIDE drys materials completely in gas or liquid phase

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About our authors

(*Continued from page 28*)

staff. Barnick joined the Institute's Frankfurt/Main branch in 1952 after extensive chemical and metallurgical physics experience with European research organizations.

John R. Strickland and **Joseph E. R. Carrier** are editor and assistant editor, respectively, of the *Chemical Economics Handbook,* a continuing research activity sponsored jointly by Stanford Research Institute and over one hundred chemically oriented companies and organizations. The *Handbook* staff is engaged in providing subscribing organizations with continuously revised and expanded techno-economic data necessary for planning and day-to-day operations.

The increasingly important problem of water conservation—both private and industrial—is one in which consultant **Russell G. Dressler** has made significant contributions. Since becoming interested in the question about three years ago, he has been conducting field trials on reservoirs in the Southwest, has developed several techniques for applying monomolecular films that appear to be practical and economical. The report in this issue comes from Dressler and **Arnold G. Johanson,** chemical director in the Chemical Products Division of Archer-Daniels-Midland.

The fundamental design data released in the report on Pall Rings by U. S. Stoneware's **John S. Eckert, Earl H. Foote, Jr.,** and **Richard L. Huntington** come from semi-works size equipment and are felt by the authors to be of direct value and use to design engineers in the packed tower field. Work is continuing on a comparative study of all commonly used tower packings and how they act in a packed column.

L. R. Honnaker, consultant supervisor in engineering materials with DuPont, has worked with corrosion engineering problems of chemical process equipment for twelve years, has made major contributions to solution of these problems by application of principles of proper selection, design, fabrication, and maintenance of stainless alloy equipment. Honnaker finds that even a seemingly unimportant process change will sometimes result in a rapid destruction of valuable equipment by corrosion.

Croxton

Dressler

Honnaker

TOWER PACKING

All the facts about HARSHAW *tellerettes*

Contained in this comprehensive booklet discussing the application of Harshaw Tellerettes to tower packing.

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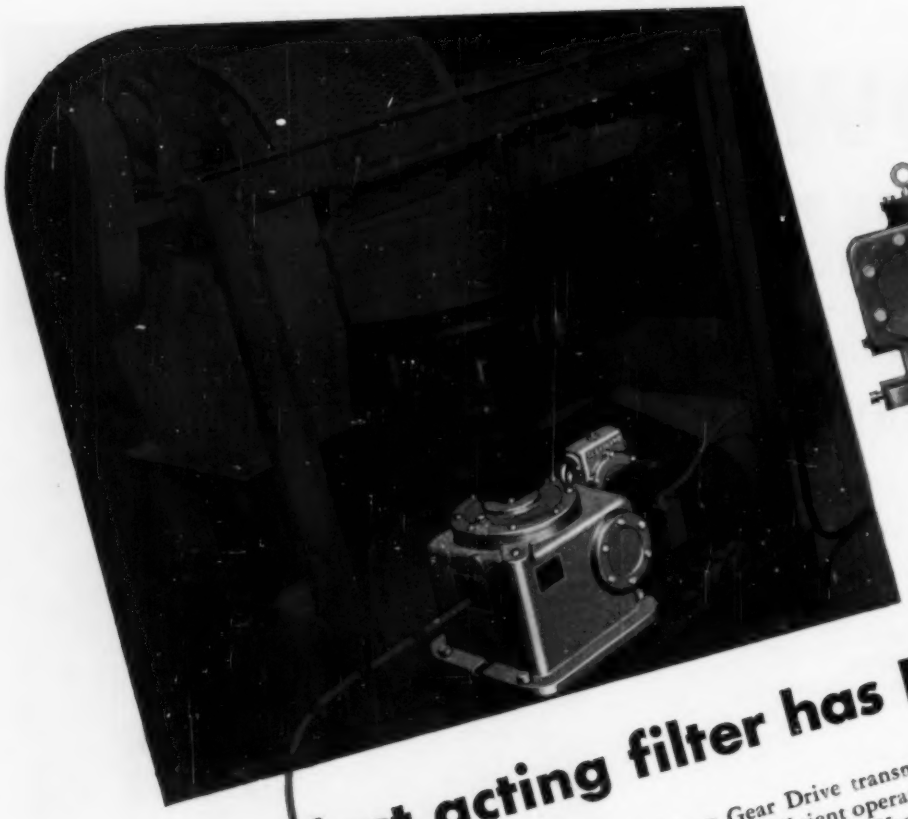

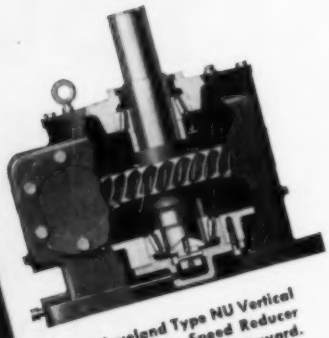

Cleveland Type NU Vertical Worm Gear Speed Reducer with drive shaft upward. Cutaway shows heavy gear shaft, rugged shaft bearing mounting and extra sturdy housing construction.

Versatile, fast acting filter has NU drive

CLEVELAND Type NU Worm Gear Drive transmits smooth, uniform speed to permit efficient operation for this Filtration Engineers' Horizontal Rotary Vacuum Filter. For coarse crystalline materials, fibrous pulps and other free-settling substances, it offers high capacity, fast dewatering and excellent cake washing.

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CLEVELAND Worm Gear Drives

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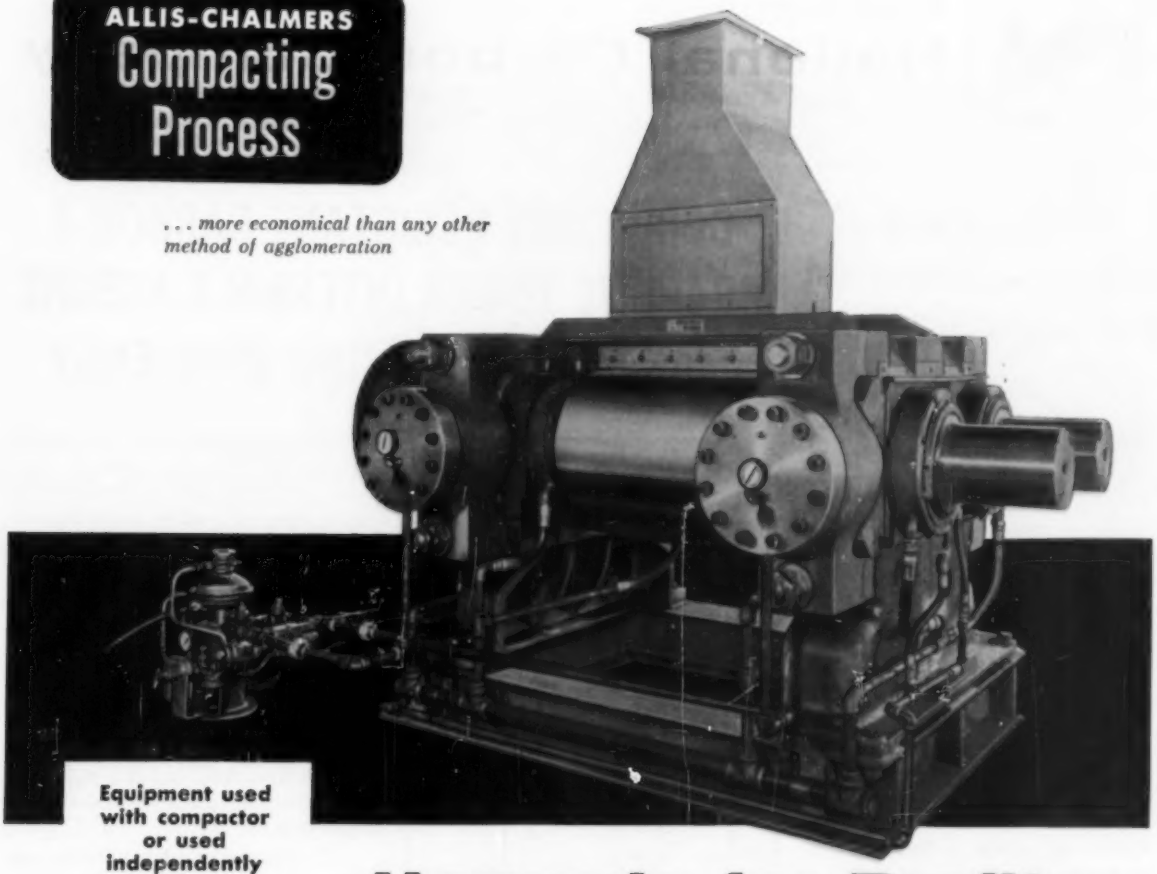
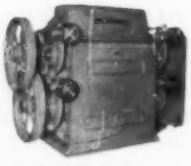


Equipment used with compactor or used independently



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Aero-Vibe Screen

Gyratory Screen

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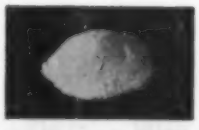
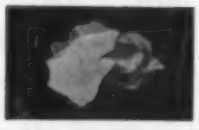
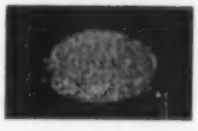
Precise control of *particle size, density* and *solubility factors* is now assured with the Allis-Chalmers compacting process. The heart of this efficient, completely mechanical system is this new Allis-Chalmers compacting mill.







Converts Loss into Profit

By-product material, too fine for use, from the original process, is first densified into slabs or flakes in the compacting mill. Agglomerated product is then granulated in the roller-type mill and separated in the vibrating or gyratory screen. This conversion of by-product material into a usable product changes loss into added profits.

Get Bulletin 07B8836 for the complete story. Ask your A-C representative for a copy, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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"National" Sales Engineer
E. S. MALKIN

E. S. Malkin is typical of the thoroughly trained and widely experienced sales engineers representing National Carbon Company to the chemical processing industries. Mr. Malkin graduated from Lehigh University with a B.S. in chemical engineering. He spent four years in National Carbon's new products development group, originating designs and developing new equipment. For ten years he has been a field engineer.

Mr. Malkin is qualified to aid in the selection, special designing and installing of carbon, graphite and "Karbate" chemical process equipment. Call your "National" Sales Engineer today . . . he can save you time, money and needless worry.

NOW..."Karbate" Armored Pipe In Larger Sizes

"Karbate" armored pipe is now available in 3 larger sizes – 6″ I.D., 8″ I.D., and 10″ I.D. – all with slip-on cemented type fittings.

Since its recent introduction, "Karbate" armored pipe has gained wide acceptance throughout the industry. For example, a recent insecticide plant installation utilized large quantities of 3″, 4″, 6″ and 8″ piping.

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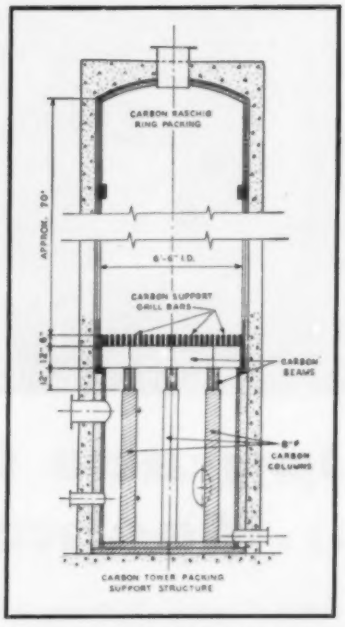


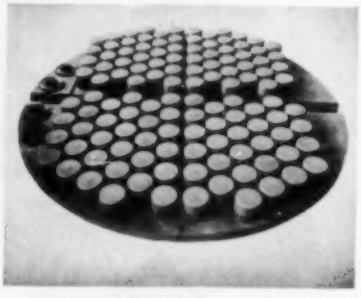
Diagram of a typical carbon tower packing support structure.

"Karbate" plate-type tower packing support installed in a primary phenol stripping column. Here the slotted cap design increases the free area.

Carbon, graphite and "Karbate" Impervious Graphite packing support structures, bubble cap trays and sieve trays are used by major oil and chemical companies in applications such as: *caustic scrubbing towers – ethyl alcohol (sulphuric alkylation) stripping towers – anhydrous HCl stripping towers – carbon dioxide absorption towers* (pulp and paper mills).

Even after years of operation, the design efficiencies of these tower internals have remained at a high level because of no formation of corrosion products.

Carbon and graphite internals can be subjected to temperatures of several thousand degrees (F) without distortion or loss of strength. In addition, rapid changes of temperature will not cause thermal shock failure. In operating temperatures up to 340 degrees, "Karbate" internals can be used with a reduction in dimensions. This is due to the increased strength this material offers over plain carbon and graphite. **Request Catalog Section S-7340.**



"Karbate" bubble cap tray installed in a secondary phenol stripping column. 10′ diameter tray having 124-4″ I.D. bubble caps. 10 such trays are installed in the column.

NATIONAL TRADE-MARK
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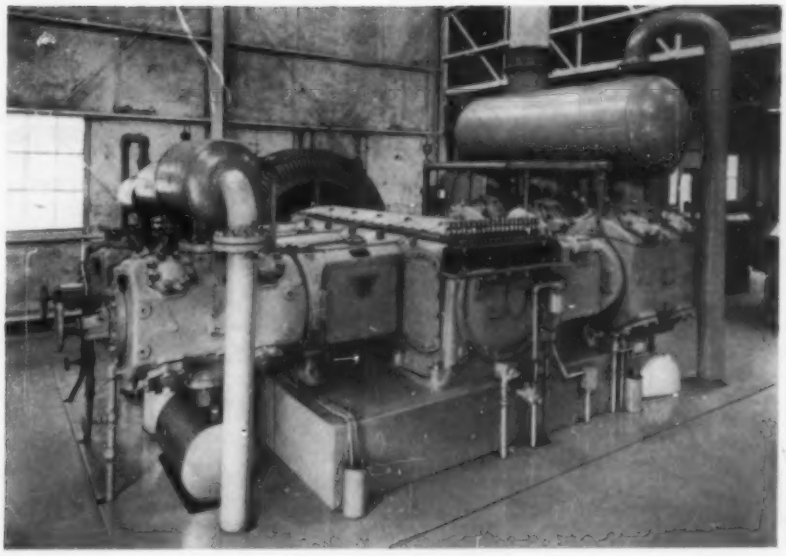
Located in the Oakland, *California plant of the Pacific Oxygen Company, this 5-stage Cooper-Bessemer FM, rated 800 hp at 300 rpm, handles the compression of air from atmosphere to 2250 psig.*



at Pacific Oxygen...

17,000 hour check proves continuous availability of **Cooper-Bessemer** *compressor*

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Not in many years have industry and the nation faced a new year fraught with more uncertainties and conflicting trends both on the domestic front and in the foreign field. The sudden realization that the United States has apparently fallen behind the Soviet Union on the scientific front and especially in the ability to build rockets and long range missiles is not yet seen to be an effective factor in reversing the continuing downtrend in business. It is as if business, conditioned to more than a decade of inflationary demands on the part of the consumer, is waiting out the present period with a policy of caution and economy.

Curtailed Operations

Symptoms of a slowing down in business activity are showing up in the falling off of steel operations to below 70 per cent of capacity, cutbacks in autos to bring inventories more in line with sales. There are operating reductions in other consumer goods fields: GE and American Radiator have been cutting down output of consumer items. In the business machine field, Underwood Corporation has let out 3,000 workers in two large New England plants and others in the field are understood to have been curtailing operations, possibly indicating a disinclination on the part of business managements to refurbish their office facilities for the time being.

Railroad carloadings are still down and complaints of declining passenger traffic both on railroads and airlines are being heard.

In contrast to this picture of declining activity, the most recent statistics show personal income to be virtually levelled off at an all time high and steel production to be about where it dipped to in mid-1955, and well above the highest level reached in 1954. Total U.S. industrial production is shown to have dipped only to about the low point for 1956, and is likewise well above 1954 and, for that matter, much of 1955. Department store sales and stocks are at just about the same level as mid-1956. One of the great oddities of our present period is the continuing high level of wholesale prices for almost all commodities—in the face of declining sales volumes. Whether this is an indication that business management, with its eye on the continuing high level of consumer income, is not being stampeded into competitive price-cutting remains to be seen.

Chemicals Steady

In the meantime, the chemical industry, noted for its stability in times of set-backs affecting many other segments of manufacturing industry, is continuing its production virtually at previous high rates. Its leaders are now more or less unanimous in looking forward to quiet business at best in the coming months, and very few look for any marked upturn until after mid-year. Slowdowns in a number of major chemical consuming industries (such as automobiles) will certainly have their reflections in the first half of 1958. Meanwhile, although some chemical price levels are better, the industry is still suffering from its "cost-price squeeze" and can hardly look for much relief until volume moves ahead considerably. This is particularly true for the petroleum industry, which saw the first recent major rise in the price of crude during the Suez crisis and adjusted prices for consumer products upward accordingly. With consumption of stocks falling, competitive activities have lowered the prices of petroleum products to about pre-Suez levels, producing a pinch. An exception is the drug segment of the process industries. Drug firms completed their most profitable year in 1957, through continual introduction of such new products as tranquilizers.

Looking Forward

Chemical executives continue to express their confidence in the long-range future and there are no indications that major companies will curtail expansion programs this year, although the starting of new expansion projects is being delayed. In this connection the major engineering-construction firms are finding the high level of construction activity in Europe a consoling stopgap factor in maintaining their levels of activity.

One of the best barometers of process industry activity is the level of equipment sales. One executive who has been compiling extensive information about the present situation, and who is with an organization having broad process industry coverage, has summed up his prediction as follows: "Sales for chemical plant equipment, which fell during the 3rd and 4th quarters of '57, have showed signs of revival during the past few weeks. Using the last quarter of '57 as a base, I predict lower sales for the 1st quarter and a slight rise during the 2nd quarter of '58. Then, a sharp upswing in the 3rd quarter, and a very sharp further upswing in the 4th quarter. The reasoning behind this: Competitive unleashing of another round of research- and development-based products and processes, made feasible by greater availability of capital through easier money policies, and by a return upward of stock market prices, which proportionally affect the borrowing power of the process operating firms. . ."

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opinion and comment

WHAT THEY THINK ABOUT SCIENTISTS

The Purdue Opinion Research Panel, a function of Purdue University, has recently surveyed the opinions and attitudes of more than 8,500 teen-age high school students toward scientists and science. This survey uncovered the fact that:

19% of our teen-age youth (surveyed) say scientists are more likely than other people to be mentally ill.

34% say scientists cannot have a normal family life.

38% say most scientists are geniuses.

53% say the scientist has no thought about the consequence of his work.

30% think scientists are impractical in the way they try to solve problems of everyday living.

28% think scientists are "more than a little bit odd."

20% think scientists have little regard for humanity.

25% think scientists in universities are removed from everyday life.

54% think scientists are more likely to be radical about matters outside their own field.

38% think scientists are willing to sacrifice the welfare of others to further their own interests.

14% say the scientists are likely to be unpatriotic.

23% think most scientists are not religious.

Other views of our teen-agers were revealed: (a) fifty per cent believe that the government should control scientific findings; and, (b) student opinion is divided as to whether the willingness of scientists to reject traditional beliefs may lead to confusion and disorder.

In reporting and discussing this survey before chemical engineers at the A.I.Ch.E. Annual Meeting in Chicago, President F. L. Hovde of Purdue, under whose supervision the panel operates, had these comments to make: "The results of this poll give a sobering picture of how our youngsters look at science and scientists in the most advanced (technologically speaking) nation in the world. As long as such large numbers of our youth hold such attitudes it will be difficult for our scientific corps truly to achieve professional status in our society."

That such opinions are not exclusively youths', is indicated by the finding that income level of family, educational level of mother, and place of residence, are related to the degree of favorable opinion towards scientists expressed by the youth.

Thus there is now positive evidence that far too many people in our country regard scientists and science in an unfavorable and, we believe, unrealistic light. It is true that such attitudes toward scientists may not apply specifically to engineers, and Mr. Hovde intends asking the panel to get a check on this. In the meantime, Mr. Hovde emphasized that "advancement of engineering depends on the advancement of basic science," and stated his belief that all engineers should have a direct interest in any factors which could affect such advancement negatively.

It should be now abundantly clear that a positive public relations effort is called for, if the opinions and attitudes expressed in this survey are to be changed significantly within any reasonable period of time. The AAS has just taken a step toward doing this on behalf of scientists, by approving in principle a five-year, $1½-million, public relations program. That the engineers could now well justify such a program tailored to their specific needs, would now seem likely.

J.B.M.

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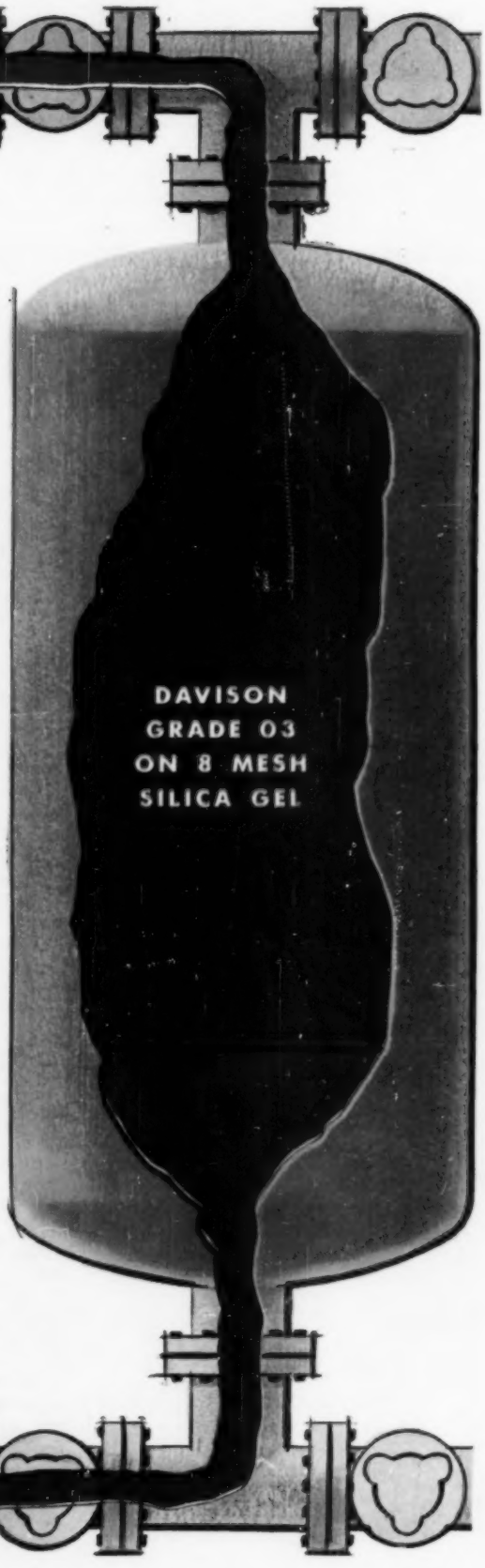

Progress Through Chemistry

DAVISON CHEMICAL COMPANY

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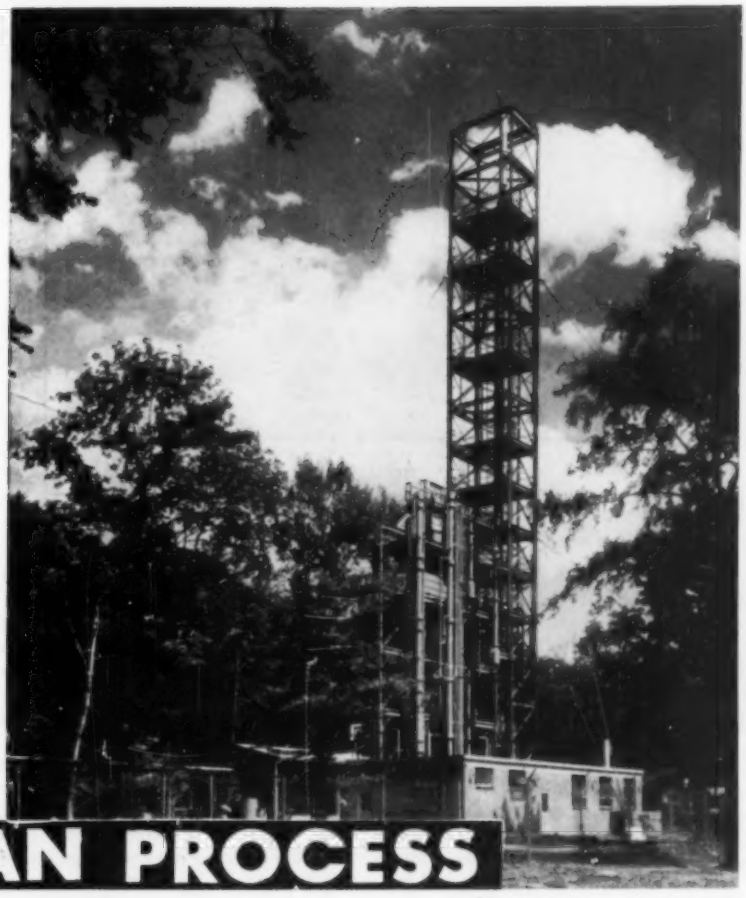


Fig. 10. View of semi-works gas recovery and purification unit.

EASTMAN PROCESS

for cracking light hydrocarbons to ACETYLENE and ETHYLENE

G. A. Akin, T. F. Reid, and R. J. Schrader *

Research Laboratories, Tennessee Eastman Company
Division of Eastman Kodak Company, Kingsport, Tennessee

The Eastman process for decomposing light, saturated hydrocarbons into acetylene and ethylene, described in the accompanying article, is significantly different from previously known processes. With propane and natural gasoline as cracking stocks, conversions to acetylene and ethylene of up to 56 wt. % from propane and 58 wt. % from natural gasoline were obtained in a year-long operation of one-million pound a year furnaces.

Only in recent years has the production of acetylene from saturated hydrocarbons become a commercial reality. However, in spite of their relative infancy and the fact that the conventional carbide process still accounts for an estimated 85% of the total acetylene production in the United States (*1*), the processes based on the use of saturated hydrocarbons as raw materials are becoming increasingly important.

This paper is concerned with a process developed in the Research Laboratories of Tennessee Eastman Company

* R. J. Schrader's present address is Texas Eastman Company, Longview, Texas.

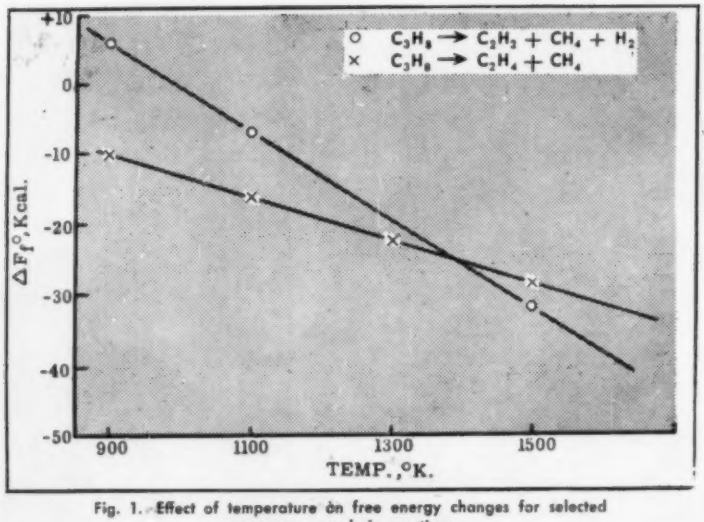


Fig. 1. Effect of temperature on free energy changes for selected propane pyrolysis reactions.

for the pyrolysis of light hydrocarbons to acetylene and ethylene. This process can be employed to manufacture a product having a wide range of ratios of acetylene to ethylene.

In the years since World War II, acetylene as a chemical raw material has experienced a steady, if not spectacular, growth. However, according to a recent estimate (*2*), a greatly increased rate of growth during the next five years is predicted, with a U.S. consumption of 840 million pounds for chemical syntheses in 1961. This would represent a 77% increase over the approximately 475 million pounds consumed in 1956. Although a majority of this increased requirement can reportedly be supplied by the existing carbide process facilities, it seems reasonable that the economics of the situation will result in the installation of additional facilities for the production of acetylene from saturated hydrocarbons.

The phenomenal growth of ethylene as a chemical raw material has been well reported. Indications are that its rate of growth will continue for several years. An annual consumption of 4 billion pounds by 1960 has been forecast (*3*).

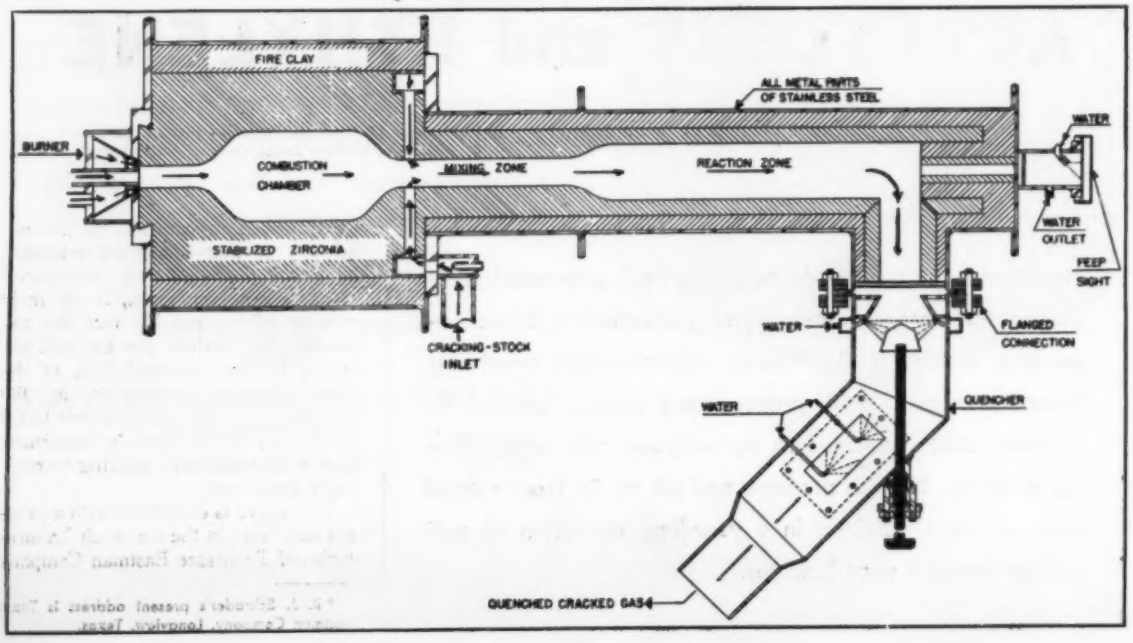
In several publications (*12, 13, 14, 15, 16*), the conditions necessary for cracking low-molecular-weight hydrocarbons to acetylene have been discussed. The key to acetylene production from saturated hydrocarbons is to supply rapidly and uniformly the relatively high heat necessary for reaction. Methods previously reported supply this heat by employing an electric arc, a regenerative furnace, or by partial combustion. In an effort to improve these methods, a research program was undertaken to develop a process that would give comparable or better yields and would (1) eliminate the high electrical energy requirements of the arc process, (2) eliminate the cyclic operation of the regenerative furnace process, and (3) either reduce or eliminate the relatively high oxygen requirements of the partial-combustion process. In the Eastman process these objectives are achieved by rapidly and thoroughly mixing the hydrocarbon with hot combustion products.

The idea of supplying the energy for cracking hydrocarbons by directly mixing them with hot combustion gases is not new. Use of this idea to produce gasoline-like products from petroleum oil was described in a patent (*4*).

An apparatus for utilizing this idea was suggested in a 1938 patent (*5*), and in 1944, a suggestion to employ this method for producing acetylene was made by Hincke (*6*).

In April, 1957, a U. S. patent (*7*) covering the specific process described here was issued to R. J. Schrader and assigned to Eastman Kodak Company. In the course of this research, semiworks furnaces with capacities of 1 million

Fig. 5. Cross-sectional view of semi-works furnace.



pounds per year were operated for a total of 12 months, some being operated for as long as 100 days. For 6 months the off gases from these furnaces were processed to recover acetylene and ethylene as pure products. This recovery was accomplished in a plant that employed the Hypersorption process and selective absorption. This paper will be limited to the operation of the cracking furnaces; a later paper will deal with the operation of the entire plant.

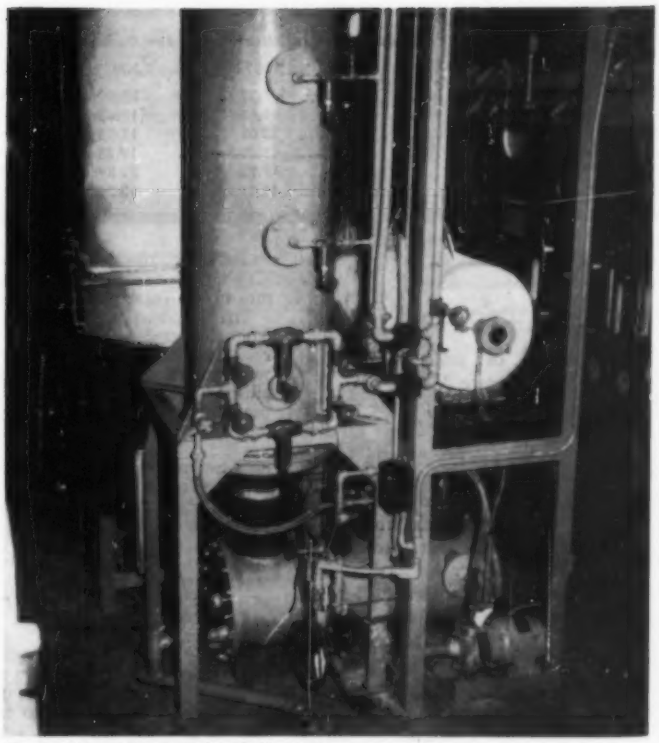


Fig. 9. View of semi-works cracking unit.

Theoretical Considerations

Possible reaction mechanisms for the pyrolytic reactions of hydrocarbons have been described in previous publications (*8, 9, 10*), but these mechanisms will not be reviewed here. However, it is of interest to examine the thermodynamic feasibility of the pyrolysis at various temperatures of lower hydrocarbons to acetylene, to examine the magnitude of the energy requirements of such reactions, and to inspect the available knowledge on the conditions required to carry out such reactions.

The free energies of formation of many of the materials of interest in the pyrolytic reactions of hydrocarbons are available (*11*) and provide a guide to their relative stabilities (see Table 1). These data show that, at 1,100° K., acetylene is the least stable of the compounds listed. In spite of the fact that it is unstable thermodynamically, the rate of decomposition of acetylene is negligible at low temperatures and pressures.

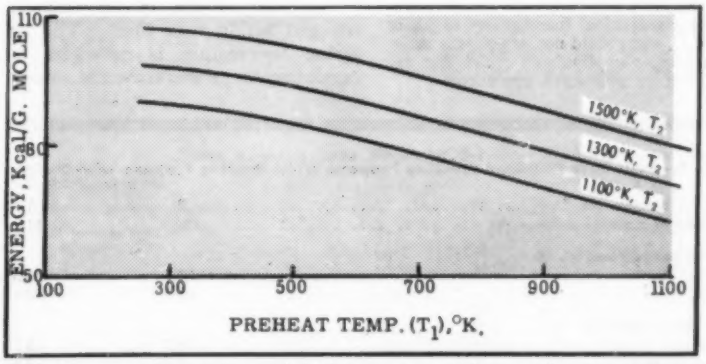
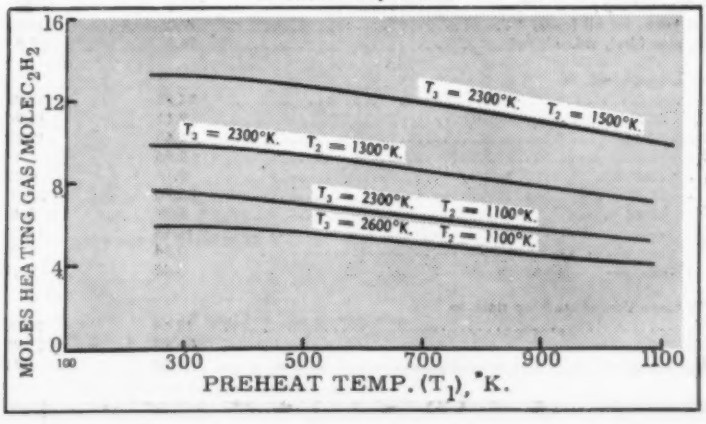


Fig. 2. Energy requirements for pyrolysis of propane to acetylene at selected temperatures.

From such matters the free energy change for the decomposition of propane to acetylene, ethylene, methane, and hydrogen can be calculated. Figure 1 is a graphical representation of this change as a function of temperature. Although it is indicated that acetylene can be formed at temperatures as low as 1,100° K., it is apparent that ethylene is the favored product until temperatures of about 1,400° K. are reached.

Reactions involved in producing acetylene from saturated hydrocarbons require large amounts of energy. Figure 2 illustrates the heat requirement for the cracking of propane from an initial temperature of T_1 to acetylene, methane, and hydrogen at a final temperature of T_2. This figure is only a rough approximation of the requirements for actual cracking since the reaction does not proceed in such a clear-cut manner.

Fig. 3. Heating gas requirements for pyrolysis of propane to acetylene at selected temperatures.



From these values can be calculated the number of moles of heating gas at an intial temperature of T_3 required to provide the necessary heat when mixed with propane at a temperature of T_1 to produce one mole of acetylene

Table 1.—Free Energies of Formation in Kilocalories per Gram-Atom of Carbon

	1,100° K.	1,300° K.	1,500° K.
Methane	7.22	12.50	17.79
Acetylene	19.67	18.43	17.21
Ethylene	15.08	17.02	18.96
Methylacetylene	18.40	19.25	20.11
Propane	17.78	22.89	28.03
Benzene	11.17	12.76	14.35

at a temperature of T_2 according to the following equation:

$$C_3H_8 \rightarrow C_2H_2 + CH_4 + H_2 \qquad (1)$$

This number of moles is plotted against T_1 in Figure 3.

Values in Figure 2 illustrate the desirability in a process of this kind of preheating the hydrocarbon to be cracked and of operating in such a way that the gas temperature at the end of pyrolysis is as low as possible. This latter condition, however, results in a situation favorable to the formation of ethylene as well as acetylene. Figure 3 also illustrates the desirability of using heating gas at temperatures as high as feasible, considering other requirements.

Results of early experiments on high-temperature cracking in carborundum tubes at Tennessee Eastman Company led to the following conclusions:

- **Even at short reaction times the dissociation of aliphatic hydrocarbons above methane is substantially complete at temperatures required to produce acetylene.**
- **The products of pyrolysis are mainly acetylene, ethylene, methane, and hydrogen.**
- **The ratio of acetylene to ethylene formed is strongly influenced by the pyrolysis temperature.**
- **Resulting products should be cooled rapidly to a temperature below about 700° K. to prevent continued decomposition of desirable products.**
- **Steam and carbon dioxide do not react rapidly with hydrocarbons under high-temperature cracking conditions.**
- **Carbon and tar formation is excessive at long contact times or at excessively high temperatures.**

Process

To simplify an explanation of the Eastman process, a schematic flow diagram of the semiworks unit is shown in Figure 4.

A suitable fuel, such as natural gas, is preheated in preheater No. 1 and fed to the burner mounted on the furnace combustion chamber. Either oxygen or air mixed with a metered quantity of low-pressure steam is preheated in preheater No. 2 and also fed to the burner. The amount of oxygen or air used is normally less than the stoichiometric quantity required to burn the fuel gas. Amounts up to about 95% of the stoichiometric quantity are satisfactory. These streams mix and burn in the combustion chamber of the cracking furnace. The preheat temperature of these streams, the amount of steam added, and the oxygen-to-fuel ratio are controlled to give the desired temperature of the combustion products.

The combustion products discharge from the combustion chamber through a restricted opening at a relatively high velocity. The hydrocarbon cracking stock plus some low-pressure steam is preheated in preheater No. 3 and is fed into the high-velocity stream of combustion products immediately after it leaves the combustion chamber. The cracking stock and the combustion products mix in a venturi section and pass into the reaction zone where the dissociation of the cracking stock to form unsaturated products is completed. The gas mixture is then water-quenched to stabilize the reaction products. This gas stream is made up of approximately a dozen gases, the major components being carbon dioxide, acetylene, ethylene, carbon monoxide, hydrogen, methane, and, in the case of air combustion, nitrogen. This cracked-gas stream is then processed to recover the desired products.

One of the important items of equipment in this process is the cracking furnace. It must withstand temperatures in the combustion chamber up to about 2,500° C. and should not deteriorate under the startup and shutdown cycles that are attendant to prolonged operations.

A cross-sectional view of a semiworks furnace is shown in Figure 5.

The annular mixing-type burner is shown at the extreme left, mounted on the end of the combustion chamber. Adjacent to the combustion chamber is shown the mixing zone and then the reaction-completion zone. The inner course of the combustion chamber, the mixing zone, and the reaction zone were fabricated from stabilized, zirconia refractories. The outer course was composed of refractory fireclay. The exterior wall of the furnace was made of stainless steel and was of all-welded construction to eliminate leaks.

The experimental furnaces were installed horizontally and constructed so that the gases left the reaction zone through an opening at right angles to the axis of the furnace. This arrangement permitted the installation of a sight port on the end of the furnace. The interior of the reaction zone could be observed through this sight port.

A quench chamber was attached to the discharge port of the furnace. In the equipment described here, the gases were cooled with water spray to below 100° C. Because of the construction and method of operation of this semiworks furnace, a carbon deposit was obtained on the cold surfaces where the quencher was attached. A scraper was used to break this material loose periodically.

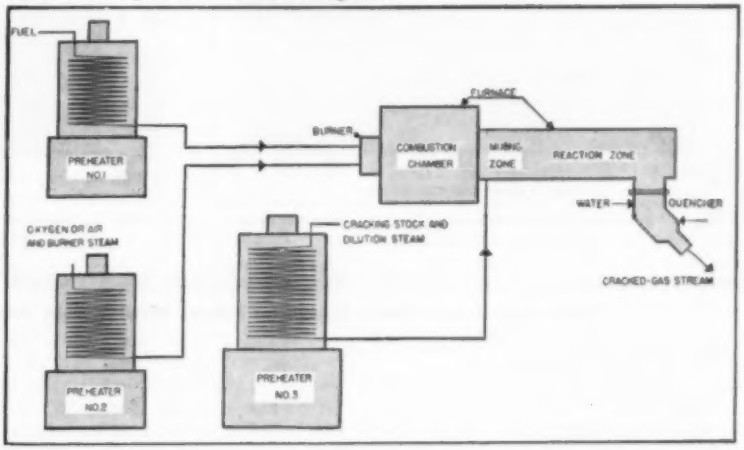
The variables that affect the composition of the product are the reaction temperature and the reaction time. By varying the reaction temperature, the composition of the product can be changed within wide limits. The reaction temperature is controlled by regulating the temperature and amount

Table 2.—Basic Data Obtained Cracking Propane While Burning Propane with Oxygen

Material balance No.	2	3
Duration of material balance, hr.	120	48
Product composition, wt. %		
C_2H_2	33.7	45.5
C_2H_4	66.3	54.5
Feed rates, std.cu.ft./min.		
Oxygen	26.7	26.7
Fuel (C_3H_8)	5.6	5.6
Cracking stock (C_3H_8)	28.6	24.0
Burner steam (added to oxygen)	116.0	116.0
Dilution steam (added to cracking stock)	0.0	0.0
Calcd. flame temp., ° C. (17)	1,985	1,985
Preheat temp. for all feeds, ° C.	600	600
Off-gas rate (dry), std.cu.ft./min.	98.8	91.8
Off-gas analysis, vol. %		
CO_2	14.75	15.95
C_2H_2	9.11	10.96
C_2H_4	16.68	12.20
C_3H_8	0.96	0.47
O_2	0.17	0.25
H_2	33.70	37.00
CO	5.99	6.40
CH_4	18.14	15.96
C_3H_6	0.04	0.00
N_2	0.46	0.81
Wt. % conversion of cracking stock to		
C_2H_2	18.64	25.00
C_2H_4	36.70	29.90
C_3H_6	3.18	1.71

of both the combustion gases and the cracking stock. The reaction time can be changed within limits by adjusting the volume of gas put through the unit. However, the latitude of suitable reaction times is so nearly the same for a wide range of ratios of acetylene to ethylene in the product that a given furnace design can be used to produce a range of product compositions with only a small change in capacity.

Fig. 4. Flow diagram of semi-works cracking unit.



Experiments

Experimental furnaces of the type described above were operated for approximately 12 months. During this time studies were carried out using both air and oxygen to support the generation of combustion products. Data were obtained while cracking propane with oxygen-supported combustion products and while cracking propane and natural gasoline with air-supported combustion products.

Since methane is one of the major products of the pyrolysis, it was of interest to determine the effect, if any, that the addition of methane to the cracking stock would have on the yield of acetylene and ethylene. Experiments were carried out to obtain data showing the effect of adding natural gas to a propane charge stock.

In addition to the basic data, such as product concentrations, yields, and raw-material requirements, other information was of interest. Among these items were the character and amount of higher unsaturates and aromatics produced. The cracked-gas stream was analyzed by mass spectrometry to obtain these data.

Another point of interest was the amount of carbon and tar produced. Although it was difficult to define numerically the amount under any given set of conditions, qualitative observations were possible. Studies were made that showed the effect of the addition of burner and dlution steam to the furnace on the amounts of tar in the off gas.

Conversion Bases

The conversions of the various cracking stocks to acetylene and ethylene were calculated from average values of variables measured over the durations of the material balances. These variables were determined as follows: all feeds to the furnace were measured by flowmeters that were carefully calibrated. The furnace off-gas rate was continuously measured by a positive-displacement flowmeter and was periodically checked by collection in a gas holder. While operating with air as the oxidant, the off-gas rate was also checked by a nitrogen balance. The composition of the off gas was routinely determined by Orsat analyses.

Table 3.—Basic Data Obtained Cracking Propane While Burning Natural Gas with Air

Material balance No.	4	9	11	33	39
Duration of material balance, hr.	32	80	32	2	2
Product composition, wt. %					
C_2H_2	33.7	46.7	53.8	62.1	82.6
C_2H_4	66.3	53.3	46.2	39.9	17.4
Feed rates, std.cu.ft./min.					
Air	137.5	123.5	123.5	123.5	123.5
Fuel (natural gas)	15.2	13.7	13.7	13.7	13.7
Cracking stock (C_3H_8)	29.2	18.0	16.0	15.6	9.6
Dilution steam (added to propane)	0.0	13.0	11.0	0.0	20.0
Burner steam (added to air)	0.0	20.0	20.0	16.5	9.0
Calcd. flame temp., ° C. (17)	2,120	2,000	2,000	2,000	2,050
Preheat temp., ° C.*	600	600	600	600	600
Off-gas rate (dry), std.cu.ft./min.	208	168	170	165	166
Off-gas analysis, vol. %					
CO_2	4.05	5.51	5.30	4.90	4.87
C_2H_2	4.45	4.75	4.80	5.17†	4.47†
C_2H_4	8.13	5.06	3.80	2.94†	0.87†
C_3H_8	0.42	0.12	0.00	0.00	0.07
O_2	0.10	0.19	0.20	0.10	0.07
H_2	16.60	16.62	17.05	17.25	18.33
CO	5.08	4.54	5.80	5.80	8.00
CH_4	8.60	6.82	6.05	4.00	4.33
C_2H_6	0.03	0.00	0.00	0.00	0.00
N_2	52.54	56.39	57.00	59.20	58.90
Wt. % conversion of cracking stock to					
C_2H_2	18.75	26.25	30.1	32.3	45.6
C_2H_4	36.95	30.05	25.7	19.7	9.6
C_3H_8	3.14	1.04	0.0	0.0	0.0
Tar and carbon in the off gas, 1 to 10μ particle size, estimated grains/cu.ft.	1.0-2.0		2.0-3.0		4.0-5.0

* In material balance No. 4 all feeds were preheated; in the others the fuel was not preheated.
† Values obtained by gas chromatography.

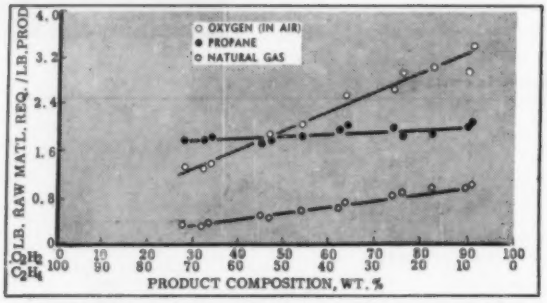


Fig. 6. Raw-material requirements for cracking propane while burning natural gas with air.

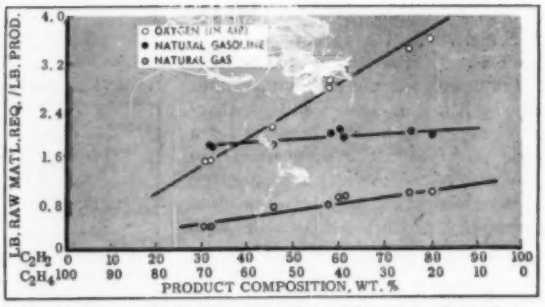


Fig. 7. Raw-material requirements for cracking natural gasoline while burning natural gas with air.

Table 4.—Basic Data Obtained Cracking Natural Gasoline While Burning Natural Gas with Air

Material balance No.	13 and 14	15	19	17	22
Duration of material balance, hr.	132	72	2	2	2
Product composition wt. %					
C_2H_2	31.7	45.8	58.3	60.3	80.3
C_2H_4	68.3	54.2	41.7	39.7	19.7
Feed rates					
Air, std.cu.ft./min.	123.5	123.5	123.5	123.5	123.5
Fuel (natural gas), std.cu.ft./min.	13.7	13.7	13.7	13.7	13.7
Burner steam (added to air), std.cu.ft./min.	16.0	16.0	16.5	16.5	16.5
Dilution steam (added to cracking stock), std.cu. ft./min.	33.0	33.0	33.0	33.0	33.0
Cracking stock (natural gasoline, sp.gr. = 0.638), ml./min.	1,910	1,400	1,100	1,040	880
Calcd. flame temp., ° C. (17)	2,000	2,000	2,000	2,000	2,000
Preheat temp., ° C.*	600	600	600	600	600
Off-gas rate (dry), std.cu.ft./min.	168	165	158	154	156
Off-gas analysis, vol. %					
CO_2	5.27	5.10	5.64	5.57	5.73
C_2H_2	4.15	4.39	4.23†	4.0†	4.68†
C_2H_4	8.30	4.80	2.70†	2.47†	1.06†
C_2H_6	0.47	0.13	0.13	0.10	0.07
O_2	0.11	0.10	0.23	0.13	0.20
H_2	12.65	14.45	14.10	14.77	15.03
CO	5.16	7.10	6.67	6.70	6.73
CH_4	6.93	5.78	4.69	4.90	3.53
C_3H_8	0.04	0.00	0.00	0.03	0.00
N_2	56.92	58.15	61.23	60.50	62.70
Wt. % conversion of cracking stock to					
C_2H_2	18.7	26.6	31.4	30.5	42.6
C_2H_4	40.3	31.3	21.5	20.2	10.4
C_3H_8	3.4	1.8	0.0	0.0	0.0

* All feed streams except fuel were preheated.
† Values obtained by gas chromatography.

Table 6.—Typical Analyses of Off-gas by Mass Spectrometry

Cracking stock	Propane	Propane	Propane	Propane	Natural Gasoline	Natural Gasoline	Natural Gasoline
Oxidant	Oxygen	Air	Air	Air	Air	Air	Air
Component of off gas, mole %							
Argon	....	0.6	0.6	0.7	0.5	0.7	0.6
CO_2	15.2	5.1	6.2	5.1	5.5	5.7	5.6
N_2	....	51.8	55.1	58.6	57.2	56.6	62.6
CO	5.4	5.2	5.3	8.0	5.2	8.0	7.4
H_2	32.4	16.2	16.2	18.3	12.0	14.3	15.2
CH_4	17.3	8.0	5.8	3.7	6.4	4.6	2.9
C_2H_2	8.0	4.0	5.2	4.5	3.8	4.7	4.6
C_2H_4	18.2	7.8	4.7	0.9	8.1	4.3	0.7
C_2H_6	0.9	0.4	0.1	....	0.1	0.4	0.1
C_3H_4 (methylacetylene)	0.5	0.2	0.2	....	0.4	0.2	0.1
C_3H_6 (propylene)	0.5	0.2	....	....	0.4	0.1	trace
C_4H_2 (diacetylene)	0.1	trace	0.1	0.1	trace	0.1	0.1
C_4H_4 (vinylacetylene)	0.4	0.1	0.1	trace	0.1	0.1	trace
C_4H_6 (butyne + butadiene)	0.4	0.1	....	....	0.1	....	....
C_5H_4 (1-penten-3-yne)	0.2	0.1	0.1	....	0.1	....	....
Benzene	0.5	0.2	0.1	0.1	0.1	0.2	0.1
Toluene	trace	....	....	....	....	....	....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

During the progress of this work, gas chromatographic methods became available; and whenever acetylene and ethylene concentrations were determined by this technique, these values are reported in the tables. The values obtained by both methods were checked with numerous analyses by mass spectrometry. In those cases for which the acetylene and ethylene concentrations were obtained by Orsat analyses, the acetylene concentrations reported include higher acetylenes. Those values of the weight per cent conversion to acetylene calculated from concentrations obtained by Orsat analyses include the higher acetylenes calculated as acetylene. In the cases of the longer material balances, the off gases from this unit were processed to recover acetylene and ethylene as pure products and the quantities of these materials obtained confirmed the conversion figures reported here.

Discussion of Results

The equipment described here operated satisfactorily. Conversions to acetylene plus ethylene of 56 wt. % were readily obtained from propane. Conversions to acetylene alone of 45 wt. % were obtained with only a slight sacrifice in total conversion. Both air and oxygen proved satisfactory oxidants. With oxygen operations, the oxygen requirements per pound of product were materially less than those reported for other processes if based on acetylene and ethylene as coproducts, and some less if based on acetylene alone. There were no by-products that would present serious difficulties in the purification and recovery of the products.

Oxygen-supported vs. Air-supported Combustion. Both oxygen-supported and air-supported combustion have attractive features for use with this process. A comparison of data in Tables 2 and 3 shows that the conversions of cracking stock to unsaturates are almost identical for both methods.

Material balance No. 2 of Table 2 shows that, with oxygen-supported combustion under conditions that give a 1 : 2 ratio of acetylene to ethylene in the product, the conversion to acetylene was 18.6 wt. % and to ethylene was 36.7 wt. %. Material balance No. 4 of Table 3 shows that, with air-supported combustion to give the same product composition, the conversion to acetylene was 18.7 wt. % and to ethylene was 36.9 wt. %. Also, a comparison of material balance Nos. 3 and 9 from the same two tables shows that with a 1 : 1.14 ratio of acetylene to ethylene in the product, almost identical conversions were obtained by both methods.

The major differences in the product, are, of course, the concentrations of the desirable components of the off gases.

The results of gas analyses given in Tables 2, 3, and 6 show that because of the dilution with nitrogen the concentration of these products, when air-supported combustion is used, is slightly less than half that obtained using oxygen-supported combustion.

A point not adequately indicated in the data is the amount of tar in the off gas. As will be discussed later, the amount of steam fed to the furnace has a pronounced effect on carbon formation. Since considerably more steam is used for cracking with oxygen than for cracking with air, there is less tar formation. However, the amount formed in cracking with air is not so much that it becomes a significant factor except at high ratios of acetylene to ethylene in the product.

Any choice between the two methods must be made upon economic considerations. In the one case, there is an investment in an oxygen plant, in the other, there is an increased investment in gas compression and separation facilities. These two factors so nearly balance each other that a decision would be based on the contemplated use of the by-product gases.

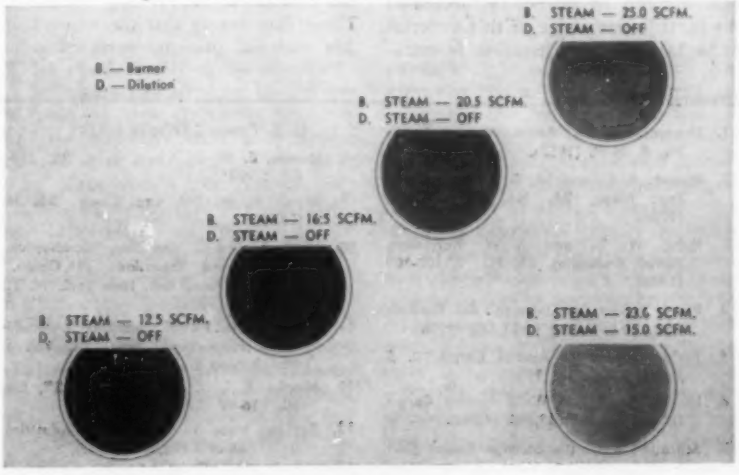
Choice of Cracking Stock. The furnace described in this report was intended primarily to crack hydrocarbons with molecular weights higher than that of methane. The majority of the experimental work was done with propane and natural gasoline as cracking stocks. Other hydrocarbons of this type should work just as well but these were chosen because (1) they were available for experimental work, and (2) their price is suitable for their use in commercial operations. Data of Tables 3 and 4 were obtained while cracking propane and natural gasoline, respectively, by air-supported combustion. In both instances data are given for a range of ratios of acetylene to ethylene in the product. A comparison of these two tables shows that slightly higher yields were obtained with natural gasoline at the lower acetylene-to-ethylene ratios. At the higher ratios the yields were slightly higher from propane.

A distinction not adequately revealed in the data is the amount of tar formation. It was immediately apparent that under the same conditions the use of natural gasoline resulted in more tar formation than the use of propane. This tar formation was controlled by the amount of steam added with the cracking stock.

Figures 6 and 7 show graphically the raw-material requirements for cracking propane and natural gasoline, respectively. A comparison of these figures shows that the fuel and air requirements for cracking with natural gasoline are approximately 10% higher/lb. of product. These higher requirements are attributed to the extra dilution steam used to control carbon formation.

Results from cracking mixtures of propane and natural gas, quoted in Table 5, are based on the propane fed, plus the 5 mole % ethane fraction of the natural gas. It is difficult to make an accurate comparison of these results with those obtained using propane alone. However, a comparison of material balance No. 11 (Table 3) with material balance No. 55 (Table 5) reveals some interesting points. For these two experiments the combustion-chamber conditions and product compositions were almost identical. In material balance No. 55 the amount of cracking stock was reduced 25%, and the dilution steam was

Fig. 8. Effect of addition of steam to furnace on tar formation.


B. — Burner
D. — Dilution
B. STEAM — 25.0 SCFM.
D. STEAM — OFF
B. STEAM — 20.5 SCFM.
D. STEAM — OFF
B. STEAM — 16.5 SCFM.
D. STEAM — OFF
B. STEAM — 12.5 SCFM.
D. STEAM — OFF
B. STEAM — 23.6 SCFM.
D. STEAM — 15.0 SCFM.

replaced by natural gas. These changes resulted in an increase in conversion to acetylene and ethylene from 55.8 to 63.5 wt. %. Although the economics of each situation will dictate whether or not this method gives the lower cost product, it certainly will be of interest under some conditions.

By-Products. A characteristic of pyrolysis reactions of this type is the formation of variable quantities of higher acetylenes, aromatics, and tar. The character and quantity of these materials present in the off gas are of importance in their effect upon the choice of gas-separation and recovery equipment. Data in Table 6 indicate that slightly more higher acetylenes and aromatics were made with the use of oxygen-supported combustion than with air-supported combustion. The amount of higher acetylenes in the off gas using oxygen-supported combustion totaled about 1.5%, whereas about 0.5% was produced using air-supported combustion. These amounts represent a slightly larger production of these materials for operation with oxygen when allowances are made for the dilution with nitrogen when operating with air.

These data also reveal that, as the ratio of acetylene to ethylene in the off-gas stream was increased, the total amount of higher acetylenes decreased slightly. Under any condition the amount of these materials present did not present a major problem.

As previously mentioned, carbon deposits were obtained on the cold surfaces where the quencher was attached to the furnace. The amount of carbon build-up within the furnace itself varied widely with operating conditions. These deposits presented operating difficulties under some operating conditions that produced a high ratio of acetylene to ethylene.

Under all conditions of operation some tar and carbon were in the off gas. Studies by microscopy revealed the particle-size range of this material to be 1.0 to 10.0μ. Quantitative measurements of the amount of these materials were difficult; so most of the observations were relative. Table 3 does show the estimated amount of these materials present for three different conditions of furnace operation. These data reveal that the amount of this material present increased with increasing ratios of acetylene to ethylene in the product.

Table 5.—Basic Data Obtained Cracking Mixtures of Natural Gas and Propane While Burning Natural Gas with Air

Material balance No.	53	55
Duration of material balance, hr.	1	1
Product composition, wt. %		
C_2H_2	68.2	54.4
C_2H_4	31.8	45.6
Feed rates, std.cu.ft./min.		
Air	123.5	123.5
Fuel (natural gas)	13.7	13.7
Cracking stock (C_3H_8)	12.0	12.0
Cracking stock (natural gas)	6.0	16.0
Burner steam (added to air)	16.5	16.5
Calcd. flame temp., ° C.	2,000	2,000
Preheat temp., ° C.*	600	600
Off-gas rate (dry), std. cu.ft./min.	168	168
Off-gas analysis, vol. %		
CO_2	4.80	4.63
C_2H_2	5.10	4.37
C_2H_4	2.20	3.40
C_3H_8	0.00	0.17
O_2	0.27	0.10
H_2	17.17	16.57
CO	5.93	5.40
CH_4	6.47	10.40
C_3H_8	0.00	0.00
N_2	58.06	54.96
Total	100.00	100.00
Wt. % conversion † of cracking stock to		
C_2H_2	41.6	34.6
C_2H_4	19.3	28.9

* All feed streams except the fuel were preheated.

† Based on weight of propane fed plus 5 mole % ethane fraction of the natural gas added to the cracking stock.

Figure 8 shows several filter papers that have filtered equal quantities of off gas. These gases were produced using different quantities of steam. As can be seen, distinctly less tar was produced as additional steam was added to the furnace. Other qualitative measurements of this kind revealed that slightly more tar was formed with natural gasoline than with propane.

The data in Table 6 indicate the presence of benzene in the off gas. In subsequent processing of the off gas (not discussed here) the presence of aromatic material was confirmed. An aromatic oil that represented 2 to 3 wt. % of the cracking stock was recovered. This oil contained approximately 65 vol. % of benzene, 19 vol. % of toluene, and 16 vol. % of xylenes and higher aromatics. Approximately 25% more aromatic oil was recovered when natural gasoline was used instead of propane as the cracking stock.

Furnace. The furnace described above was satisfactory. The major difficulty encountered in initial efforts was in building a furnace that would stand the heating and cooling cycles of experimental work. The brick construction with zirconia refractories gave good results. The structural stability and suitability of the furnace for continuous operation was demonstrated by the fact that a combustion chamber was in excellent condition after 100 days of operation.

Although the furnace described here was well suited for experimental studies, a vertical, downward-firing furnace offers some structural advantages for a commercial unit.

Acknowledgment

The authors wish to express their appreciation to those fellow-workers who contributed so much to the success of this project; especially is recognition given here to C. O. Wimbish, W. D. Carter, and G. F. Montgomery for the many contributions they made.

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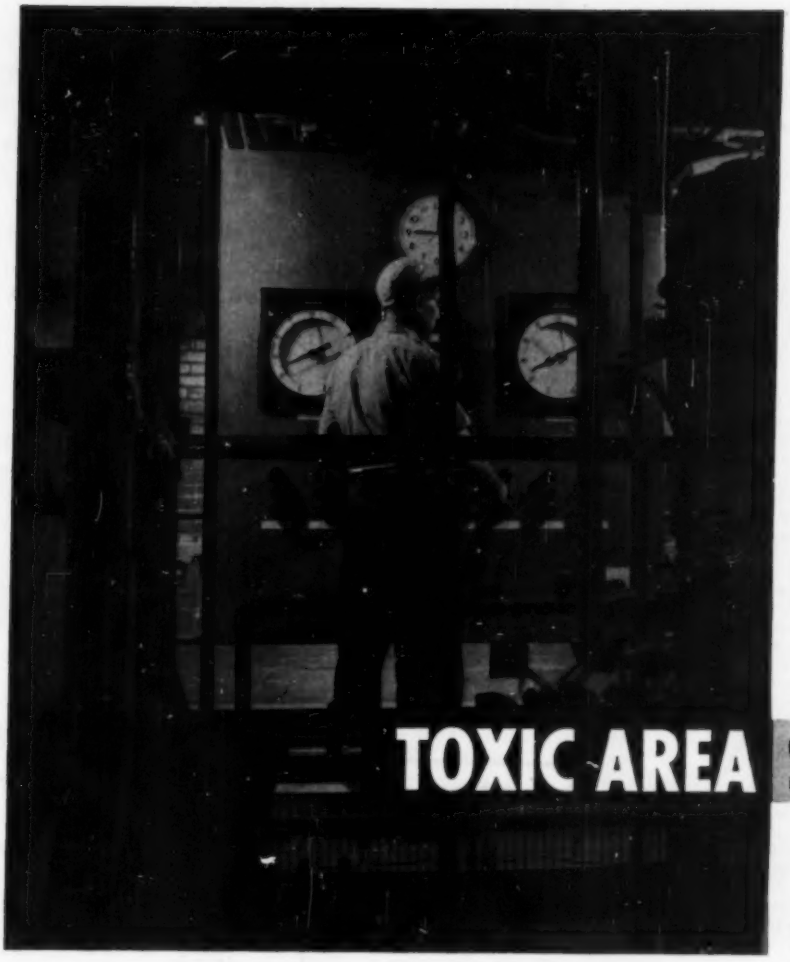


TOXIC AREA SEMI-WORKS

Panel board on main operating floor.

The toxic area semi-works described here was designed to fill the need for development of specialty organic chemicals. The pilot plant area could be a model for future expansion to plant scale of processes in which handling of obnoxious chemicals is involved.

C. J. Prizer and A. S. West

Rohm & Haas Company
Philadelphia, Pennsylvania

This article describes the details of a building constructed for the purpose of handling toxic chemicals, primarily as raw materials such as hydrogen cyanide and hydrogen sulfide, on a pilot plant scale. The building was established as part of a general-purpose semi-works and pilot plant for process-development studies in connection with organic chemical manufacture.

Prior to the existence of this special building, some toxic chemicals were handled in general semi-works operating areas; under such circumstances it was, of course, necessary to take extraordinary precautions even to the extent of precluding the use of an entire building for any other purpose. Not only was this an inefficient method of equipment use, but there remained the potential problems involved in case a sample bottle was dropped or a process line began to leak. Furthermore, it was difficult to keep all persons who might have occasion to enter the building informed regarding the toxic nature of the process in operation. These persons might be accountants, or oilers, or inspectors, or others not specifically connected with the semi-works staff.

Finally, there was the problem that without constant reminders, even the operating personnel might become somewhat callous regarding the nature

of the chemicals involved. These factors, together with the increase in the frequency of use of toxic chemicals, made it imperative that a special area be provided, and that it contain equipment operable remotely from an area distinct and separate from the equipment area.

Construction Details

EXTERNAL

Figure 1 shows a typical external elevation of a three-story building approximately 25 ft. × 25 ft. × 35 ft. high.

All brick construction was selected not only for its permanence and fireproof qualities, but also to blend architecturally with the neighboring buildings. Any masonry construction, however, because of its porosity presents the problem of decontamination. To reduce the porosity problem, all internal brick surfaces in the equipment area were coated with a special alkyd resin paint formulation. It will be noted from Figure 1 that windows appear only in the operating part of the building for reasons that are perhaps obvious; this prevents the escape of toxic fumes through broken window panes and insures that all air will be drawn through the operating area (note the air intake sections above the windows) to the equipment area, thereby keeping the operating area under a slightly higher pressure than the equipment area.

Access doors are provided at each floor level, but only into the operating area. The one exception is the double door on the first floor to permit movement of raw materials and equipment, but these doors can be opened only from the inside. This arrangement insures that only properly informed and instructed personnel will enter the equipment area and that nobody will wander into the danger zone by mistake.

INTERNAL

A typical internal elevation (Figure 2) shows in particular the separation of the operating area and the equipment area. Figure 3 is a typical elevation illustrating the way in which the major equipment pieces appear to an operator standing in the operating area. The three floor plans (Figures 4, 5, and 6) again illustrate the division between the equipment and operating areas.

It can be seen that entrance to the equipment area must be made through an air lock, the one exception being the double door on the first floor referred to previously. This double door can be opened only from the inside. Safety showers are available at each floor level in the air lock so that these locks can serve also as decontamination booths. In unusual cases, these showers could be set up to circulate solvent instead of water. A hoist is available for movement of raw materials and equipment through the open hatch area to each of the two upper floors.

The ground floor is concrete. This porous material could present a decontamination problem and if necessary could be covered with steel plate. The two upper floors in the equipment area are partly

FIRST FLOOR ►
Fig. 4.

open steel grating and partly steel plate over steel grating. The plate was installed immediately surrounding the equipment to prevent minor spills from dripping to lower floors. The open grating in the area away from the equipment provides for better vertical ventilation. Steel plate was used for flooring on the main operating floor, and for the walkway at the third floor level.

Steel grating with floor plate was considered superior to concrete for flooring for several reasons. First, it is not porous and is easily decontaminated. Second, it permits greater flexibility in relocating equipment and/or installing new equipment. Third, it allows better air circulation in the equipment area.

Figure 7 illustrates a characteristic section of the separating barrier.

Large areas of Plexiglas are used to provide adequate visibility. The Plexiglas panels are held in place by spring clips and caulking compound. Use of this clear plastic material makes it convenient to bring valve extension handles through the partition at practically any desired point. Most of the valves were located so that straight-through type of extension handles

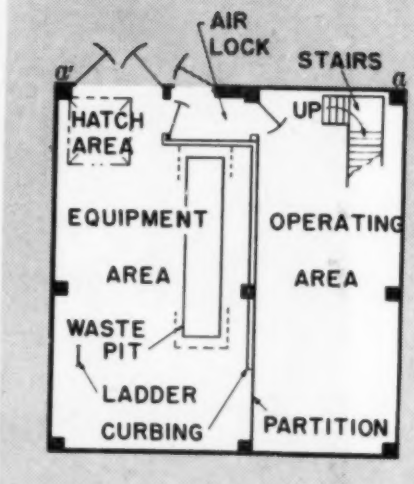
SECOND FLOOR ►
Fig. 5.

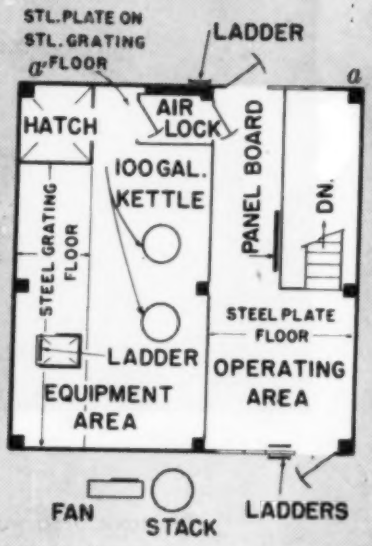
could be used. However, in some cases, particularly with the Y-type corrosion resistant porcelain valves, it was necessary to design rather elaborate extension handle systems. Wherever applicable, plug valves were used, not only for ease in providing extension handles, but also, since a system could be established, through the use of T-type handles, to determine whether the valve is open or shut (for example, bar vertical, valve closed).

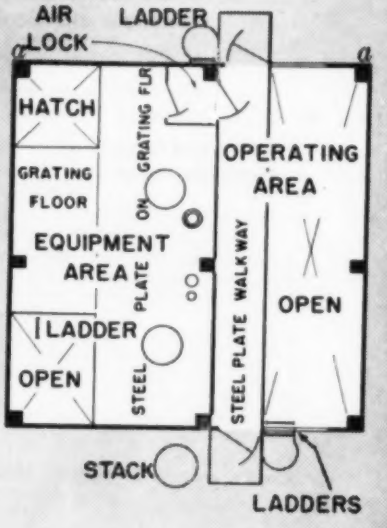
Ventilation

The major safety device is the ventilating system. Outside air is forcefed into the operating area through louvers provided above the doors and/or windows. This air passes over heaters when required for wintertime operation. The air is admitted to the equipment area through a series of openings above and below the Plexiglas barrier at each floor level. These openings have manually adjusted louvers. Figure 8 shows a typical ventilation duct-work elevation. This duct work is so located that the air must pass completely across the equipment area before entering the openings in the ducts. A blower exhausts the air

Fig. 6.
THIRD FLOOR ►







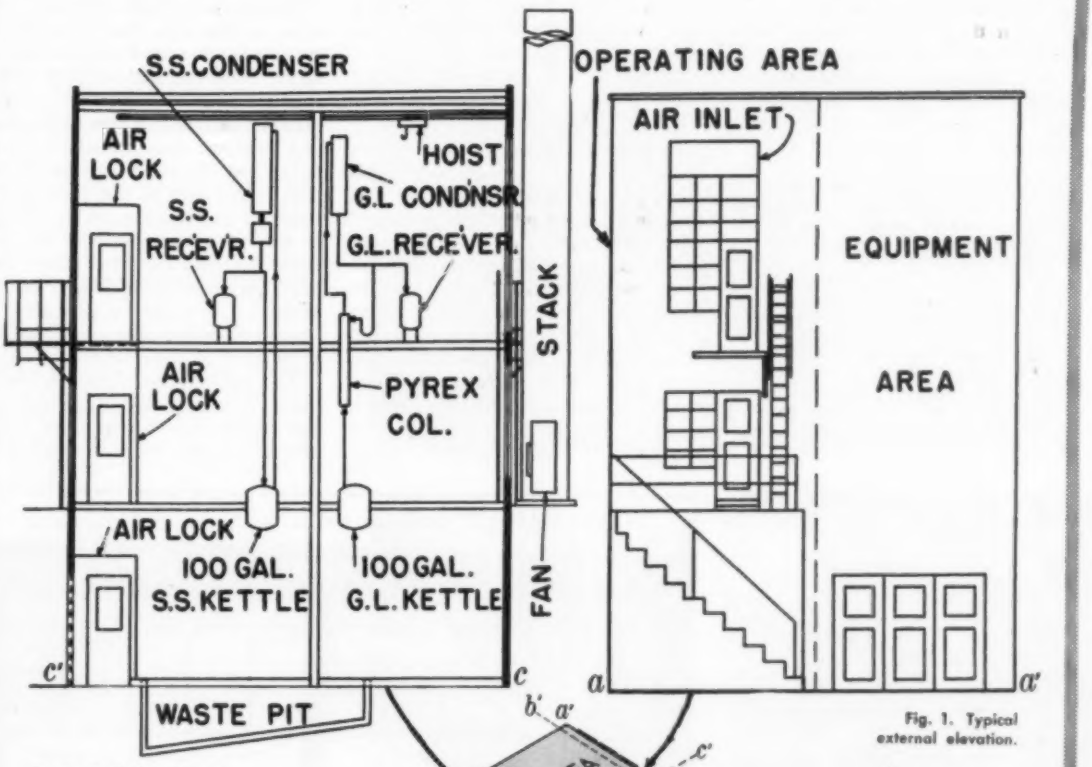


Fig. 3. Typical equipment cross-section.

Fig. 1. Typical external elevation.

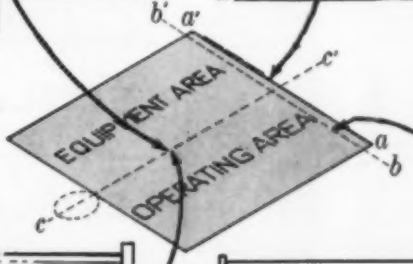
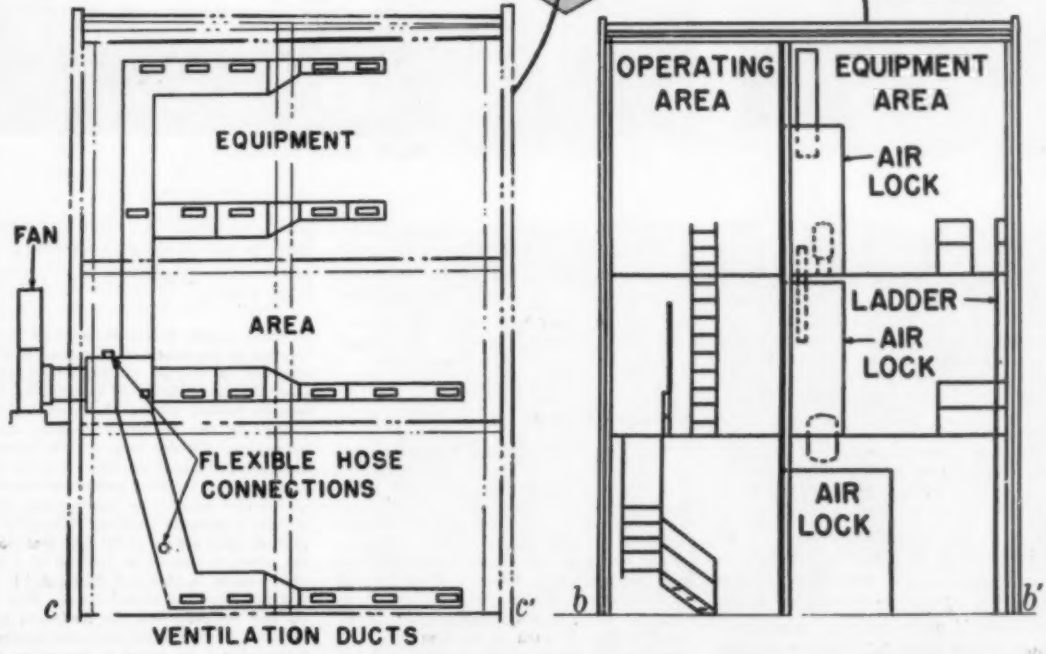


Fig. 8. Typical ventilation elevation.

Fig. 2. Typical internal elevation.



to a stack which is 125 ft. high. The total air rate is equivalent to one air change in the building every 3 min. The over-all air change rate in itself is not as important as proper distribution of the air flow to purge thoroughly the equipment area with each air change.

A large number of louvered openings in the Plexiglas barrier and corresponding openings in the discharge blower suction ducts are provided to establish good air flow distribution. Moreover, the general ventilation system is not relied upon for complete removal of toxic vapors from all corners and pockets of the equipment area, but it is supplemented with portable blowers and flexible hose exhaust lines connected to the duct work. One or more of these portable blowers can be set up to provide spot ventilation at such potential trouble points as stuffing boxes and sampling ports. These blowers are always used when it is necessary for a man to enter the area during operation.

Automatic closure of the louvers between the operating and equipment areas in case of mechanical failure of the exhaust system was not provided since both forced draft and exhaust ventilation systems are present. In addition, the high stack provides some gravity ventilation in the event of failure of both of the mechanical systems.

The stack is constructed of steel with a baked-phenolic interior lining. The duct work is galvanized steel coated internally and externally with a special alkyd resin coating formulation.

A scrubber for the exhaust air was not included with the original design, but sufficient space was allotted for installation of such a unit at some future date if required for some extremely toxic material. Normally, the concentration of toxic contaminant in the ventilation air is extremely small and dispersion from a 125-ft. high stack was considered a more than adequate safety precaution.

Liquid Wastes

In order to collect all liquid wastes including floor washings, a 500-gal. waste pit was installed below the first floor level. This pit is concrete lined with acid-brick; an asphaltic-type membrane was used between the concrete and the brick. This pit may be used to treat any toxic wastes prior to discharge to the plant contaminated-sewer system. The collected wastes may also be pumped back to the reactors for treatment. A sump pump is used to transfer the wastes to the sewer or to the equipment. As an added safety precaution, a blank flange was installed in the discharge line and this flange must be removed manually before starting the pump. This assures that the operator will not start to discharge the wastes prior to proper treatment.

Process Equipment

The process equipment is not unique.

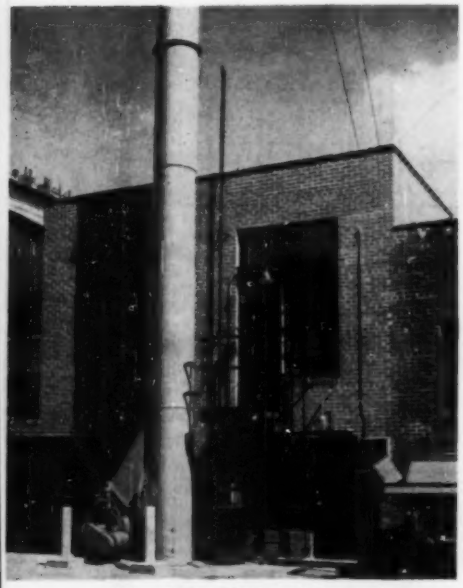
The two basic units are a 100-gal. glass-lined kettle-type reactor with packed tower, condenser, and receiver; and a 100-gal. stainless steel kettle-type reactor with condenser and receiver. Process pressures and temperatures may be varied from full vacuum to 25 lb./sq.in. gauge and from —20 to 200° C., respectively. The necessary auxiliaries such as vacuum jets, vent scrubbers, instruments, and pumps are, of course, included.

Operating Technique

The equipment and operating areas were set up with the safety of the operating personnel uppermost in mind. However, without proper operator training, operation of even so carefully designed an area as this could be hazardous. Safe procedures for entering and leaving the equipment area have been drawn up and the operators carefully instructed in these. The area is not intended to be used for nontoxic reactions since the rather strict operating procedures might be laid aside if it were known no danger existed, and in time this could lead to a breakdown in the discipline.

The safety precautions are not detailed here but only a general procedure for establishing them is presented. Clearly, each case in which a toxic material is handled must be thought out on its own particular hazard level. In general, the procedure is as follows:

• When a new and toxic material is to be handled in the course of a process study, the engineer in charge of the development is given the responsibility of investigating in detail the toxicity of the new material. He is assisted in this by the originating synthesis laboratory. On the basis of the information developed, the engineer and his group leader devise a safe handling procedure for the use of the raw material or intermediate. Special thought is given to handling methods to avoid spills or other escape of the toxic materials, but the proper procedure in the case of a spill or other release is, of course, considered in detail. The safe handling procedures are then drawn up and reviewed with the semiworks superintendent. Prior to actual operation, background information is presented to the entire operating staff during the weekly safety meetings.



External view (first floor below grade on this side).

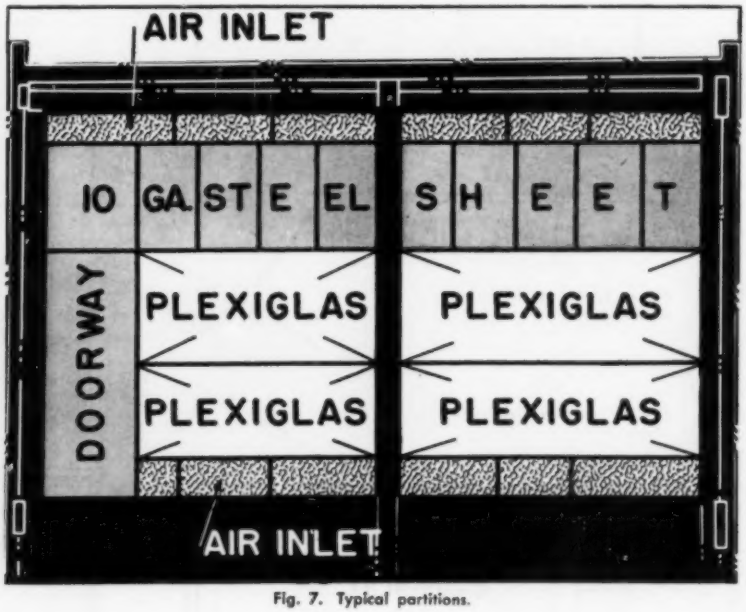


Fig. 7. Typical partitions.

• Then the operators specifically assigned to the operation of the equipment are briefed in detail on the safe handling methods. Shift foremen are, of course, included in these briefing sessions. Finally, the operating instructions are prepared in typewritten form, reviewed by the group leader, and issued to the operating personnel. During the course of the actual operation, the engineer in charge is either on the scene or can be reached quickly by telephone.

• Operating procedures are devised and equipment and lines set up and tested in advance to avoid, whenever possible, the necessity of entering the equipment area while it is in operation. Should such a move be necessary, however, special procedures have been set up. Air masks and protective suits are provided for the person entering. No person is allowed to enter the equipment area unless another worker, equipped to enter, is posted on the operating side of the barrier. As noted previously in this article, spot ventilation is provided by means of flexible hose connections to reduce the concentration level of the toxic chemical; for example, it might be necessary to tighten up the stuffing box on a reactor or repair a leak.

• Thus, by thoughtful design of this unit and by careful instruction of operating personnel, it is possible to handle highly toxic raw materials and intermediates at the same level of safety accorded less hazardous raw materials.

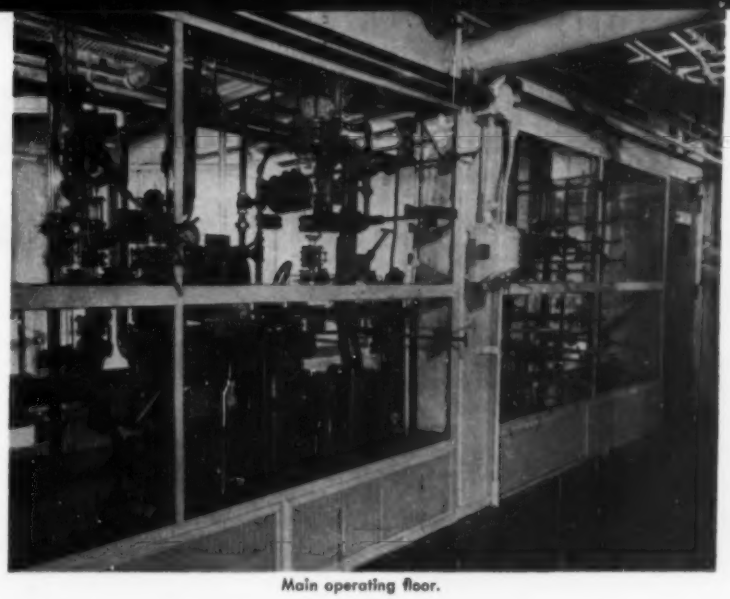
Fire Protection

It is obvious that if a small fire should start in the equipment area, the large quantity of air blowing through the area could fan it quickly to a large blaze. Some thought was given to the use of automatically closing louvers operated by a temperature switch, but this was considered impractical. The usual sprinkler system was installed and, in addition, manually operated steam-blanketing lines were installed over the waste pit, a particularly vulnerable spot, and at strategic spots around the reactors. In case of fire, the operators are trained to shut off both the intake fans and the exhaust blower immediately (the natural draft from the stack will help prevent escape of toxic fumes to the operating area) and to turn on the appropriate steam-blanketing valve. These steps are designed to keep the fire under control long enough to permit the operator to put on protective clothing and enter the equipment area with the proper fire extinguisher. Should a small fire go out of control, the automatic sprinkler system would be set off and major fire-fighting equipment would be brought up.

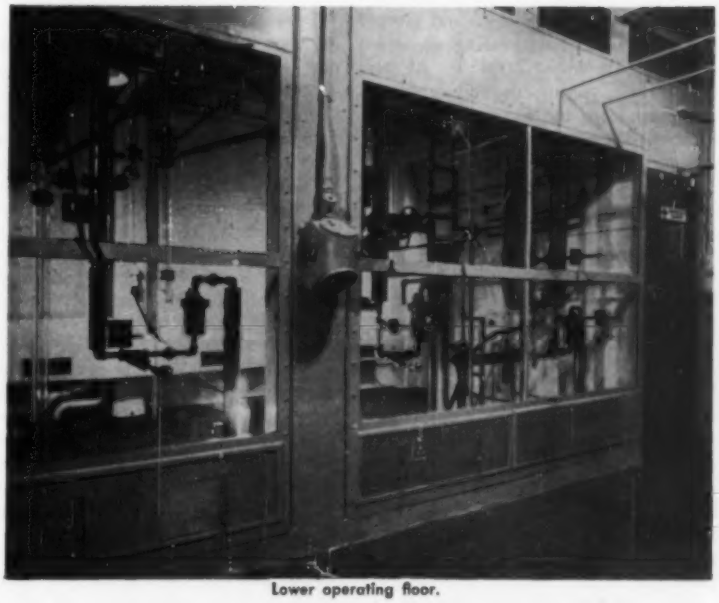
Acknowledgment

The mechanical design of the toxic area was prepared by W. F. Kamensky and K. E. Dahlen. Helpful suggestions of L. U. Spence and H. R. Moody in the preparation of this paper are gratefully acknowledged.

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

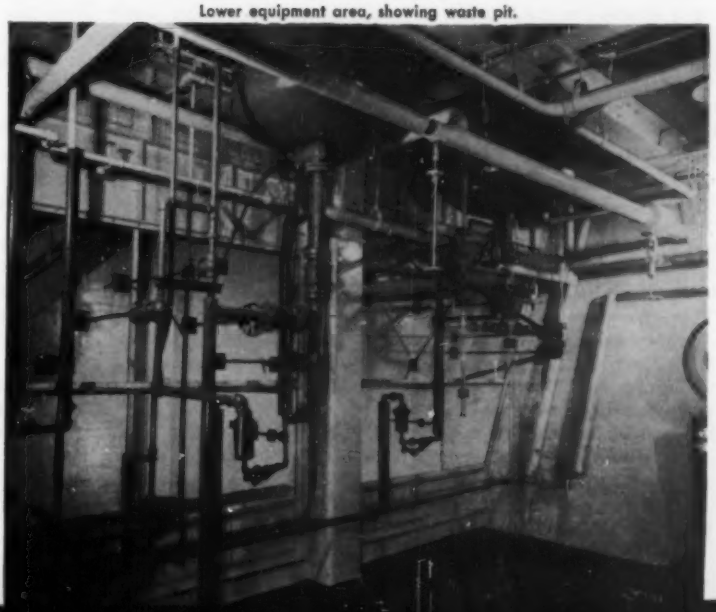


Main operating floor.



Lower operating floor.

Lower equipment area, showing waste pit.



LITHIUM EXTRACTION

from run-of-mine spodumene ore

Harold J. Andrews | Lithium Corporation of America, Minneapolis, Minnesota

Extraction of lithium from run-of-mine spodumene ore containing 1.0 to 1.5% Li_2O has been effected, and probably for the first time the direct chemical extraction of lithium from low-grade ore has been found commercially successful.

Details of Operation

The process used by Lithium Corporation of America at its Bessemer City, North Carolina, plant and reviewed by Hader, Nielson, and Herre (*1*) consists of first heating the spodumene ore to about 2,000° F. At this temperature spodumene undergoes an inversion from the natural alpha-spodumene to beta-spodumene. This operation is called "decrepitation."

In the next step the ore is finely ground, mixed with concentrated sulfuric acid, and heated to about 450° F. A base exchange reaction between the acid and beta-spodumene results in the formation of lithium sulfate, which is subsequently leached from the ore with water. This solution is then separated from the ore by continuous vacuum filters and concentrated by evaporation. The concentrated lithium sulfate solution is subsequently mixed with a concentrated solution of soda ash, and the resulting insoluble, lithium carbonate, is centrifuged and washed. The sodium sulfate in the mother liquor is recovered as a commercial-grade salt cake.

This process got its start at St. Louis Park, Minnesota, in a plant using a spodumene concentrate of 4-5% Li_2O content. Lithium losses were low, but coupled with the losses incurred in the beneficiation of run-of-mine ore, the maximum recovery from the ore deposit to the salable product was about 55%.

Experience at Bessemer City has shown that a substantially higher over-all recovery can be obtained by using run-of-mine ore directly in the chemical process than can be obtained by going through preconcentration. Thus, the direct chemical processing of run-of-mine ore has resulted in a higher over-all lithium recovery with the use of a minimum of equipment and operating personnel to obtain a low-cost-lithium extraction.

There were, however, several problems associated with the direct chemical treatment of run-of-mine ore that did not appear with previous work on extraction of lithium from concentrates. Most of the problems centered around the decrepitation and acid roasting steps; these difficulties were solved by the application of pilot studies, of novel design ideas, and of close production control.

DECREPITATION

Previous to plant design, pilot studies were undertaken to determine the per cent conversion from alpha-spodumene to beta-spodumene that could be achieved by decrepitating run-of-mine ore. These studies showed that underheating the ore would result in poor decrepitation and that overheating, or partial fusion of the ore, would result in the tie-up of lithium with gangue minerals, which would prevent its acid extraction. Results of these tests showed that the ore must be decrepitated between narrow temperature limits (a temperature band of about 100° F.) to obtain maximum decrepitation recovery. However, it was shown that high decrepitation recovery could readily be achieved in the pilot lab kiln. The tests further indicated that the best kiln product would be free-flowing with a high percentage of fines.

The design of the decrepitation equipment was carried out then on the basis of these pilot tests and on the experience gained in running concentrates at the St. Louis Park plant. Careful attention was given to obtaining the best possible control of the kiln. Because of the dusty nature of the kiln product, it was necessary to use an indirect water-cooled 10-×200-ft. rotary cooler, and to install a fan-and-dust collector in the discharge of the cooler in order to prevent excessive dusting in the kiln firing hood.

This system also made possible extremely close draft control in the kiln. Instruments were also installed on the kiln to maintain close control of the fuel rate, feed rates, and kiln temperature. Operators skilled in the use of these instruments and familiar with the appearance of decrepitated ore were able to maintain constant operating conditions and a uniform product. As a result, it was possible to attain large-scale decrepitation recovery predicted by pilot lab work.

ACID ROASTING

After initial tests showed that the over-all recovery of lithium from run-of-mine ore was higher than from concentrates, the key to the economic success of run-of-mine operations was the sulfuric acid consumption in the acid-roasting operation. It was immediately apparent that more sulfuric acid would be required per pound of lithium sulfate extracted from low grade run-of-mine ore than from 4 to 5% concentrates. Exhaustive pilot tests were carried out to determine the optimum ratio of sulfuric acid to ore and the optimum roasting temperature. Results of these tests, coupled with an economic evaluation of the decrepitation and roasting steps, indicated that lithium extraction from run-of-mine ore would yield the lowest cost lithium.

Equipment design for the acid-roasting operation centered around the materials of construction and the control of process variables. The equipment used in the roasting operation consisted of a gravimetric feeder, a mixer, a rotary kiln reactor, a leach tank, and a scrubbing system.

In this operation the ore from storage is fed continually with a controlled amount of sulfuric acid to the mixer. The mix then falls into the roaster, where the desired temperature is maintained by an automatic control of the gas rate and kiln draft. The ore discharges, together with leach solution, into an agitated tank and is pumped to the neutralizing tanks. Gases from the roaster pass through a two-stage scrubbing system and then discharge to the atmosphere.

The feeder, mixer, and roaster are all of mild steel construction, which to date has held up well from attack by 66° Baumé sulfuric acid. The acid leach tank consists of a lead-lined steel tank with a dense acid brick lining together with a neoprene-lined agitator and pump. This tank and pump unit replaced a bucket elevator that was originally used to elevate roasted ore to the leach tanks. After a two-year operation the tank lining is in almost perfect condition and neoprene

has been established as an excellent material for withstanding hot, acid, and abrasive slurries. The two-stage scrubbing system consists of an acid brick cooler and a rubber-lined scrubber, which supply a fine water mist to reduce SO_3 fumes.

The operation of the roaster consists of maintaining the proper acid to ore ratio, ore retention time, and discharge temperature. The desired acid to ore ratio is maintained by adjusting the ore rate or acid rate to the mixer and controlled by titrating for acid in the roaster feed and discharge. The ore hold-time is adjusted by varying the speed of the roaster. Ore temperature is indicated and controlled by thermocouples located at the discharge end and at several points along the roaster. Close operating control of the variables has, as in the decrepitation step, resulted in the recovery indicated by pilot lab work.

Handling System

Another feature of the Bessemer City plant that has contributed to the success of the process is the raw-materials-handling system. A slurry storage system for handling soda ash has, in particular, helped cut processing costs. Soda-ash slurry provides a saturated sodium carbonate solution essential to low-cost precipitation of lithium carbonate from lithium sulfate. In addition, use of this soda-ash system has resulted in a minimum amount of storage facilities, of handling equipment, and of operating personnel. Air slides are used wherever possible to convey ore, limestone, and hydrated lime. The air slides have proven to be a low first cost, low maintenance cost, and extremely reliable and versatile means of conveying fine mesh solids.

This Bessemer City plant was planned with the idea of extracting lithium from any grade spodumene concentrate as well as from run-of-mine spodumene ore. The maximum design low grade ore production capacity has been attained. However, with a few minor changes, the plant output has been increased to 180% of design by the use of concentrates. Because of the high present-day lithium demands, the plant has, to date, run only eleven months on run-of-mine ore, and twenty months on concentrates. A comparison of the two types of ore shows, however, that unit product costs are lower on run-of-mine ore.

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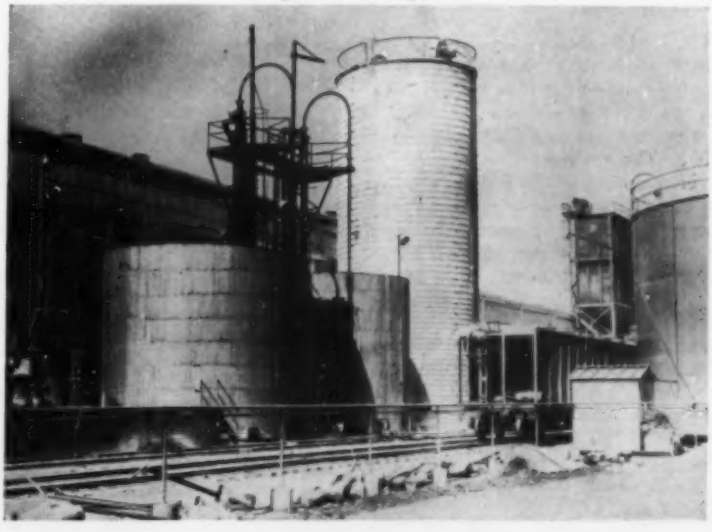
Presented at A.I.Ch.E. meeting, Chicago, Illinois.

Air view of the Bessemer City, No. Carolina plant of Lithium Corporation of America.

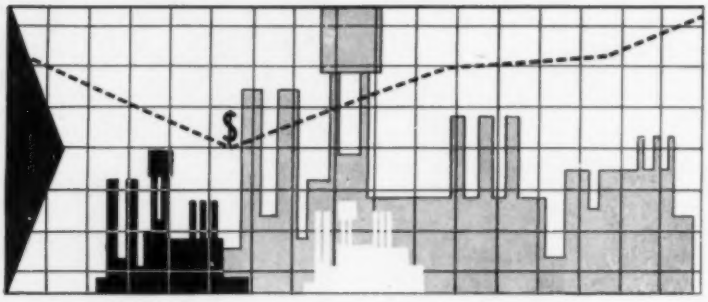
Acid roaster. Two-stage scrubber shown at right of picture.

View of plant "ore processing circuit." Kiln in foreground, cooler in background.

Soda ash slurry storage of Diamond Alkali design. Pneumatic unloading. Two storage tanks in foreground.



OPTIMUM DESIGN CAPACITY



Is it ever economical to design for a capacity in excess of sales requirements and leave equipment idle part time? Yes, says author Timpe, who believes in treating each case individually rather than attempting to apply a general formula.

Many factors enter into the choice of the design capacity of a new production unit. Some of the major considerations are:

1. Estimate of sales potential
2. Physical limitations of site, available utilities, or special equipment
3. Capital available and fiscal policy
4. Operating costs.

As will be illustrated later, particularly with respect to operating costs, the choice of one-, two-, or three-shift operation requires an economic study involving several of these factors. It is the engineer's responsibility to explore these alternatives before making his final design recommendation. A useful approach is to determine the economics of the minimum capital cost unit, then compare by increments the savings realizable from a larger investment.

Sales Estimates

Although sales estimates are not usually included in the functions of the design engineer, it is to his advantage to see that they are firmly establish d before committing costly engineering time. The engineer may be misled by overly optimistic forecasts from the sales department. If he builds an engineering proposal on such a basis, he may later be brought up short by the cost accountant who will insist on justifying the venture on the ground of some lesser budget such as current sales. The engineer may often find himself using a double standard by proposing a plant capable of meeting the rosiest sales forecasts but also economically justifiable at lower output. It is usually best to figure the justification on the most conservative figure, since returns at higher production levels will then be even more profitable.

The engineer may have difficulty in the early proposal stage in pinning down the annual capacity goal with the principal authorities. The sales department naturally wants maximum capacity to allow flexibility for short-term, high-volume promotional schemes or other purposes. The salesman is quick to complain if deliveries are late due to lagging production. This may be a major factor in some cases in favor of the one-shift idea to allow employing extra shifts for peak periods. Certainly it should be considered when economic differences are small. Whatever may be the particular case, it is essential that a mutually agreeable annual production basis be established at top levels before the design proposal is worked up in detail, and such a basis must be clearly understood.

Physical Limitations

Physical limitations must also be considered at an early stage. Limitations imposed by site and utilities are important but beyond the scope of this article. Certain types of process equipment, however, and almost all packaging equipment, are built in definite size or speed ranges. Two examples follow:

1. A commercial wiped-film evaporator is available in standard sizes, in geometric progression of both capacity and price. Exceeding capacity of one size by a small margin may mean almost doubling the installed cost for the next size unit.

2. Filling and packaging machinery is a subject in itself. Suffice it to state here that almost all such machines have definite speed limits inherent in their design. In some cases the step to the next higher capacity may be so large as to require a completely different design principle (e.g., reciprocating to rotary action) with a major change in cost. Often in a business of almost 100% packaged products this becomes the tail that wags the dog, that is, upstream process equipment is tailored to meet finishing line speeds.

In brief, then, the cost factors and capacity limits of certain special machinery must be taken into account in establishing optimum design capacity.

Capital Available and Fiscal Policy

Fiscal policy varies somewhat among companies, and a detailed discussion of corporate finances will be left to experts in that field. Naturally most managements favor projects giving the quickest return on investment, either as savings or increased gross profits. The concept of payout time is one common yardstick, and is defined here as the number of years required to recover the proposed investment by savings or increased profits once the plant is in operation. The annual cost of this investment, however, figures as a debit in the computation. The usual annual charges on increased capitalization are: depreciation, maintenance, property taxes, insurance, and interest.

In the writer's experience the annual charges just referred to have totaled from 8 to 12% of the investment, excluding interest. In addition, a new venture may require some demolition or alterations to existing buildings and equipment, cost of which is written off as a nonrecurring expense the first year. This portion is not capitalized and is not subject to the above annual charges, although it is still included as part of

* T. W. Timpe is project engineer in the Central Engineering Division.

Theodore W. Timpe *

Colgate-Palmolive Company
New York, New York

the investment. Except in cases where such expenses are substantial, they do not materially affect the payout time calculation.

If the company must borrow money from outside on a long-term basis to finance a venture, the interest on the loan may be a valid annual charge. If the project is financed from working capital or otherwise budgeted internal funds, such interest is seldom charged, depending on the company's policy. However, when capital outlays are budgeted and funds available are limited, those projects with the most attractive payout will win. All cost factors must therefore be properly stated to give an accurate picture to management of the relative worthiness of projects competing for funds.

Operating Costs

Operating costs may be substantially influenced by choice of process or design of equipment. Here, however, concern centers only on those cost factors depending on production rate. These are:

- Capital costs—depreciation, maintenance, insurance, and taxes as described previously—are usually all in direct proportion to the investment. These charges, of course, will be lowest for the small unit designed to operate three shifts continuously.
- Labor costs are not always in direct proportion to the number of operating hours per year. Premiums are usually paid for labor on second and third shifts, and overhead is not always evenly divided. Where a large operating crew is required, the labor savings by going to fewer shifts of operation may outweigh the higher capital charges of the larger investment, as examples to follow will show. It is most important, therefore, that the designer establish the labor force required for the plant as a part of the proposal, and take early steps to keep crews low by efficient design.
- Utilities costs may or may not be affected by intermittent vs. continuous operation. There may be a rate saving in using power during off-peak periods which could favor night operations. The cost of warm-up periods for evaporating, drying, or similar operations may at times be significant. Where applicable, these factors must be considered in the economic analysis.

Table 1.

Investment	3 Shift	2 Shift	1 Shift
Land	$100,000	$100,000	$100,000
Buildings	300,000	350,000	425,000
Utilities	450,000	530,000	695,000
Process equipment	1,300,000	1,670,000	2,380,000
Total investment	$2,150,000	$2,650,000	$3,600,000
1. Increment investment	0	500,000	1,450,000
Capital Charges			
Building Depreciation	9,000	10,500	12,800
Equipment Depreciation	109,000	137,500	187,500
Equipment Repairs	61,500	76,500	105,000
Taxes	28,700	35,700	49,000
Insurance	1,200	1,500	2,000
Total Capital Charges	$209,400	$261,700	$356,300
2. Increment Capital Charges	0	52,300	146,900
Direct Operating Costs/Shift			
15 men/shift @ average $6,000/yr.	270,000	180,000	90,000
3. Increment savings	0	90,000	180,000
4. Net Savings 3 — 2		37,700	33,100
Payout time, 1/4	(4 yr.)	13 yr.	44 yr.

It follows, therefore, that it is not always a simple matter to size a plant even when annual production goals are established. The lowest first cost does not always yield the best return. With so many factors to balance, a shortcut approach is not recommended. It is rather suggested that all figures be developed with as much accuracy as time and available data permit. This includes investment estimates. It has not been Colgate's practice to scale up costs of basic equipment only, or use other methods of that type in order to arrive at plant cost estimates in any stage. Almost invariably there are complications which preclude such generalizing. Therefore, the company prepares a definitive flow diagram and layout at the start, then goes through an estimating checklist literally from A (for alterations) to Z. Such care is usually justified by not quoting a hastily prepared figure to top management which is later remembered just when it is hoped that top management will forget. When ballpark figures are nevertheless demanded, the engineer must stress their limitations when presenting them.

The following illustrations, derived from three actual cases, may not be viewed as ideal examples because of various special conditions; however, they are far from unusual and serve only to emphasize the need for individual analysis rather than general rules.

In case 1, the minimum three-shift plant is economically justified. Case 2 favors the middle of three alternates. Case 3 shows the attractiveness of increasing the capacity of an existing plant, but the analysis could just as easily have applied to an entirely new venture.

Case 1: 1, 2, or 3 shifts

A new installation was required to produce an ingredient to be used in an existing product whose sales budget was well established, hence the yearly output was solidly fixed. The first

Table 2.

	60/min.	120/min.	260/min.
1. Investment	$250,000	$306,000	$380,000
2. Increment	.....	56,000	130,000
3. Annual capital costs	27,500	33,800	42,000
Annual labor cost	84,000	40,000	18,000
4. Increment labor cost (compared with existing plant)	44,000	.....	—22,000
5. Total annual expense 3 + 4	71,500	33,800	20,000
6. Freight savings	157,000	157,000	157,000
7. Net savings 6—5	85,500	123,200	137,000
8. Payout time, 1/7	2.9 yr.	2.5 yr.	2.8 yr.
9. Increment savings	.....	37,700	51,500
10. Increment payout, 2/9	.....	1.5 yr.	2.5 yr.
Operating shifts/yr.	600	300	150

Table 3.

	Plant A Existing	Plant B New	Savings
Direct Production Cost			
Raw materials	$1,037,800	$945,800	$92,000
Labor & personnel expense	436,400	267,600	168,800
Variable overhead	89,500	29,400	60,100
(some supervision, maintenance, and utilities)			320,900
Additional Expense of Investment ($700,000)			
Depreciation		34,500	
Maintenance		15,200	
Taxes		5,500	
Insurance		500	
		55,700	(55,700)
Net annual savings			$265,200
Payout time			2.6 yr.

estimate was for three-shift continuous operation, which also had process advantages. There were, however, some disadvantages to around-the-clock operation, so the alternatives of one and two shifts were also studied. For each case capital estimates were made from separate flow diagrams and equipment sizes. Furthermore, in analyzing operations it was estimated that fifteen men were required per shift, including operators, laborers, direct supervisors, and direct maintenance men. This is exclusive of general supervisors and other personnel who are on hand on day shift only and should not be considered in this comparison.

Since the three-shift plant is the lowest first cost, it is used as the reference point. Incremental costs are then figured for the alternatives as shown in Table 1. Some figures are fictitious but of proper order of magnitude to illustrate this case and other cases that follow.

For the three-shift case, the payout time shown in parentheses is listed for comparative purposes. This number is not derived from any figures in the table, but came from a separate computation designed to justify the minimum investment.

It is seen, then, that in this case the extra investment required to operate on one or two shifts is not attractive, since the relatively small crews and resultant low labor savings do not justify the additional cost over the minimum.

Case 2

A product was being made at one plant only for general distribution. Growing sales caused the unit to approach its capacity limit. Rather than expand the existing facility, freight savings indicated a new unit at another plant location was economical. Nominal capacity, on which the savings estimate was based, was taken as 20% above existing sales for the reapportioned distribution at the new unit to allow for expansion. The existing unit was considered already paid for out of profits and its amortization not included in the calculations, even though its output would be reduced.

The process consisted of batch-making facilities and a packaging line. The batch equipment presented no particular problem since it could be sized to match packaging speeds. In packaging, however, several choices were possible:

- Lowest cost—the simplest type automatic line, capacity 60 units/min.
- Intermediate cost—120/min. automatic line.
- Highest cost—automatic, 260/min.; no prior company experience with this type machinery.

Case 2 also differed from Case 1 in that operators could be used elsewhere in the large plant when not employed on this product. It was therefore most economical to run any equipment selected at maximum speed, and perhaps for less than the full 240 days/yr. Labor costs were therefore figured on an hourly basis, but with premiums for second and third shifts.

In Table 2, it is noted that all payout periods are good and there would appear to be little choice. However, by an analysis on an incremental basis, it is evident that the 120/min. plant is justified by paying off the added cost in 1.5 yr. The 260/min. plant has a larger payout by comparison although still attractive.

With reference to the last row of figures, operating shifts per year: the factory can operate 240 days/yr. for a total availability of 720 shifts excluding week ends. The 60/min. plant would be near capacity at the start, which would hardly be wise from a sales standpoint. The 120/min. plant would require 60 second shifts/yr. and would provide a reasonable cushion for expansion. If efficiency were improved above guarantee limits as could be normally expected in a plant of this type, the second shifts may be entirely eliminated. The 260/min. unit

Table 4.

Production—Units	67,000			100,000			160,000		
	Existing	*New*	*Savings*	*Existing*	*New*	*Savings*	*Existing*	*New*	*Savings*
Raw materials	$630,500	$630,500	.....	$945,800	$945,800	.....	$1,574,400	$1,513,200	$ 61,200
Labor & personnel expense	176,100	119,700	56,400	267,600	179,600	88,000	530,100	287,300	242,800
Variable overhead	19,600	19,600	.....	29,400	29,400	.....	118,700	47,100	71,600
	$826,200	$769,800	$56,400	$1,242,800	$1,154,800	$88,000	$2,223,200	$1,847,600	$375,600
Additional expense of investment		$ 6,900							
Depreciation		3,000							
Repairs		1,100							
Taxes		100							
Insurance		$11,100			$11,100			$11,100	
New annual savings			$45,300			$76,900			$364,500
Investment		130,000			130,000			130,000	
Payout time		2.9 yr.			1.7 yrs.			0.4 yr.	
Operating shifts/yr.	480	300	180	720	450	270	1,150	720	430

would have almost a fivefold expansion potential, which could hardly be justified for this particular product. The 120/min. plant was therefore recommended and approved on both economic and expansion potential grounds.

Case 3

Plant *A* first made a product at the rate of 100,000 units/yr. Anticipated expanding sales and an improved process resulting in lower product cost justified plant *B* at 100,000 units/yr., at a cost of $700,000. The new operations at plant *B* proved so successful in reducing cost that a study was made to increase its output and eliminate production at plant *A*. It was found that an additional investment of $130,000 to break bottlenecks would boost output to 160,000 units. Even if sales did not rise to this figure, it was possible that labor savings at the higher production rate would justify the investment. Incidentally, this was one of those processes limited by special machinery; an increase beyond 160,000 units would require a minimum extra cost of $350,000.

Consider first the basis for the original investment of $700,000 to supplant the older plant *A*.—Basis, 100,000 units. Only costs changed by the new plant are listed in the analysis shown in Table 3.

Examine plant *B* on the regular (100,000 capacity) and proposed (160,000 capacity) bases at three levels of annual production: 67,000, 100,000 and 160,000. For the latter, it will be necessary to compare production costs of the proposed facility with present capacity based on 100,000 at plant *B* and 60,000 at old plant *A*. Results are shown in Table 4.

It is thus seen that the additional investment to increase capacity is justified by:

(a) A comparable payout period even at lower production rate

(b) A 1.7 year return at existing production levels

(c) An attractive return for future sales expansion in lieu of reactivating plant A with its higher production cost.

Conclusions

- **When considering the economics of a new venture, investigate the possibility of building in higher instantaneous capacity to reduce production costs.**
- **The incremental cost-and-savings approach is a useful tool to emphasize the possible benefits of additional investment.**
- **All factors, especially those which are unique to the case under study, must be closely analyzed to present the accurate economic picture management deserves.**
- **Other factors excluded, additional capacity is justified when its cost can be returned in equal or less time than the basic investment.**

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

RESEARCH AND THE GREATNESS OF MAN

In the seventeenth century, when many of the important foundations of modern research were laid, Francis Bacon observed that the true aim of science was "to extend more widely the limits of the power and greatness of man." This concept is as valid today as it was 300 years ago. A constantly increasing number of scientists are impelled to push back frontiers of knowledge by basic and fundamental research through the knowledge that they are helping to improve the lot of man. From this discussion of contract chemical research in Europe, it may be seen how a small part of the European research effort, almost catalytic in size, is helping to fill a gap, spread a scientific gospel, and knit together ethnic groups who differ widely in their concepts of politics and economics—but not of science.

Research is not new in Europe—far from it. Bacon was making his observations while Jamestown was being settled. The Royal Society had just been founded and Newton was publishing his ideas while New Amsterdam was becoming New York. The pioneering spirit, however, seems to have provided fertile soil for the growth of research in America in many directions while conservatism and the temporary security of empires caused much of that in Europe to be academic in its approach.

contract chemical research in EUROPE

Frank C. Croxton * *and M. A. W. Barnick* †

Battelle Memorial Institute
Columbus, Ohio

The annual volume of research in the United States is an oft-repeated multibillion dollar figure. In other countries the total is less well known, but there are numerous examples of manufacturing firms investing 3 to 5 per cent of sales in research. For Germany's Farbwerke Hoechst, in 1956, the figure was more than 5 per cent. During a recent 18-month period, Farbenfabriken Bayer built four new laboratories, just one of which cost nearly $4 million. Research has been, and is, an extremely important activity in Europe just as in the United States. Prior to the end of World War II, however, there was one marked difference, not so much in degree as in significance. This was the absence, there, of the service known as contract research which appeared in this country at the time of World War I. Not until 1947 was it available in Europe. As a matter of fact, the term "contract research" is quite new. For some years we have spoken of farmed-out research or projects at research institutes, but these names are not easily adopted by our French, German, Spanish, or Italian speaking friends by direct translation. Contract research (Vertragsforschung), the term adopted in the German language, is in rather general use in English now. It would be well to understand that the Europe being considered in this article

* Assistant Director in Charge of Operations in Europe.

† Director, Battelle Institute e.V., Wiesbadenerstrasse, Frankfurt/Main, Germany.

does not include those countries behind the iron curtain. It consists of the seventeen OEEC countries, which are:

Austria	Italy
Belgium	Luxembourg
Denmark	Netherlands
France	Norway
German Federal Republic	Portugal
	Sweden
Greece	Switzerland
Iceland	Turkey
Ireland	United Kingdom

With this list it will be shown how generally the idea of contract research has been adopted in Europe.

Contract Research Facilities in Europe

Before 1947, it has been said, there was no mechanism by which a European manufacturer could have research done by contract as he might have done it within his own research department. In this country, however, through Mellon Institute of Industrial Research, founded in 1914, and Battelle Memorial Institute, established by the will of Gordon Battelle in 1923, as well as several other institutes of more recent origin, facilities and abilities were available to industries and government agencies which were demanding them more and more frequently.

GREAT BRITAIN

With the success of the American research institutes in meeting these research needs, a move began in the United Kingdom just after World War II to establish one for the British. Accordingly, the Almin Group of companies formed Fulmer Research Institute, which was patterned after Mellon and Battelle but was adapted to British requirements. Officially opened in 1947, Fulmer is now an institute with a staff of 107 people and a research budget of £125,000 a year. About half of this volume is for the British government, 25 per cent for British industry; the remainder is sponsored by American government and industry. It is encouraging to note that an institute such as Fulmer has little difficulty with staff recruitment. Since Fulmer does a miniscule fraction of the research in Britain, the suggestion that a research institute acquires technical manpower to the detriment of industry is not valid. It might be pointed out that if Fulmer did a substantial fraction of Britain's research it should be excused or even encouraged in its recruiting because its volume of work would be *ipso facto* evidence that the firm was satisfying a serious need.

In 1948 the consulting firm of MacTaggart and Evans became Sondes Place Research Institute, named for the residence which houses it, located at Dorking, Surrey. Where Fulmer has tended to specialize in inorganic chemistry and nonferrous metallurgy, Sondes Place Research Institute has dealt mainly with industrial chemistry and chemical engineering. With a staff of eighty-five, Sondes Place is similar to Fulmer in that it does research not only for industry but also for the British government.

Recently a new group has come to Great Britain which certainly can be said to offer contract research facilities. In 1944 the British government acted to aid the economy of some of the more remote areas of Scotland. It was felt that the harvesting and processing of seaweed could be remunerative and so the Seaweed Research Laboratory was established near Edinburgh. By 1956 it had nearly completed its work and a royal commission recommended that it be dissolved. The laboratory and staff were acquired by Arthur D. Little, Inc., and it became Arthur D. Little Research Institute. This group has begun by doing research primarily for American firms, but it is clear that sponsorships will develop in other quarters and in various areas of science.

There are, of course, many organizations in Europe which do research for others who need the service. It is to be emphasized, however, that only those specifically mentioned, plus Battelle Institute, which will be described more fully, do contract research in the sense used in this discussion.

Comment

- **Generally, it can be stated that the idea of contract research has by and large been accepted by European industry and that when there is an assurance of complete secrecy, sponsor and contractor have become close enough to permit rapid and effective solutions of problems.**
- **The European scientist has approved the team-work principle and when used with the same care as in the United States, he accepts it, enjoys it, and produces good results while participating in team research.**
- **There is no clear pattern of research subject matter in Europe, but work has been done in physics (electronics and electrical engineering), chemistry, metallurgy, mechanical engineering, economics, and ceramics.**
- **Research seems to be stimulated by commercial competition. In Europe, much of the competition, but not all, is among companies in various countries rather than within one. Thus, many factors such as availability of raw materials, special conditions of labor, power cost, and tariffs influence competition. With decreased restrictions of commerce imposed by national boundaries (due to the European Common Market and the Free Trade Area), technical advancement and productivity will become more important. More research will be needed.**

In 1918 the Department of Scientific and Industrial Research was formed in Great Britain. Among its own laboratories are numbered the National Physical Laboratory, the Chemical Research Laboratory, and the Mechanical Engineering Research Laboratory. In addition, however, there are forty-one industrial research associations, many of which have their own laboratories, financed partly by the government and partly by the member companies. These groups have done much important research of value to the sponsoring industry. It is not their purpose to solve a problem to enhance a single company's competitive position, domestic or worldwide.

GERMANY

In 1948 the Max Planck Society for the Advancement of Science (The Max-Planck-Gessellschaft zur Förderung der Wissenschaften e.V.) was founded for the purpose of reactivating the aims of the Kaiser Wilhelm Society. It is an independent association dealing principally with broad, general problems. It is essentially completely independent of industry or government. The Max Planck Society consists of a number of institutes mainly related to industries or to scientific disciplines. They are located throughout the German Federal Republic and receive most of their support from the state governments. Their annual budget is now in excess of DM30 million. The director of each institute is completely free to staff and run it as he sees fit, and to choose the research program he desires. An example is given by the recent experience of the Max Planck Institute for Coal Research (Max-Planck Institut für Kohlenforschung) where Professor Karl Ziegler selected a program of research dealing with the polymerization of olefin hydrocarbons by new and novel means. The result was a new procedure for manufacturing high-density polyethylene which is extremely interesting both scientifically and commercially. The direct relationship of this work to the coal industry is not immediately obvious, but the benefits to society of the efforts of Professor Ziegler and his coworkers are. Still, the work of the Max Planck Institutes is not contract research.

Also in Germany is the A.i.F., or Union of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsvereinigungen), founded in 1954. It is an "umbrella" organization which coordinates thirty-five industrial research societies which themselves are not far different from the British Research Associations, even to the approximately one-to-one

support from government. Another research liaison organization is the V.f.V., or Central Agency for Contract Research (Vermittlungsstelle für Vertragsforschung). It is designed to bring together industry and science as represented by consultants, professors, professor institutes,* testing laboratories, and the true industrial research institutes. It will be noted that contract research is construed quite broadly. Neither the A.i.F. nor the V.f.V. has laboratories or performs research. They are coordinators and intermediaries. Finally, mention should be made of the Fraunhofer Society for Applied Science (Fraunhofer Gesellschaft für angewandte Wissenschaft), which assists German research efforts by supplying patent advice. In addition, it comments on proposed research for the guidance of those who might provide supporting funds.

SPAIN

An interesting organization, which to an outsider is also rather complicated, exists in Spain. This is the National Enterprise "Calvo Sotelo" (Empresa Nacional Calvo Sotelo), which has built and is operating a shale oil plant at Puertellano. It is entirely owned by I.N.I., the National Industrial Institute (Instituto Nacional de Industria), which participates by stock ownership in some sixty Spanish companies. Calvo Sotelo has an applied research center in Madrid specializing in petrochemicals and conducting research for its own commercial ventures as well as for others among the I.N.I. companies. The Puertellano plant mines shale, retorts it, distills the oil and hydrogenates certain fractions to produce lubricants in such quantity as to make Spain independent in this regard if the isolation of 1939-45 should be repeated.

FRANCE, DENMARK

A nation which, in its government, has had a Ministry of Scientific Research and Technical Development is bound to be one with a strong feeling for science and technical advancement. This is the case in France where one will find the National Center for Scientific Research (Centre National de la Recherche Scientifique), which operates somewhat as the National Bureau of Standards does in the United States without the maintenance-of-standards functions. CNRS has some research laboratories of its own at Moudon, near Paris. In addition, however, it also sponsors research, particularly at the universities. The important petroleum, metallurgical, electrical, automotive, and chemical companies of France are conducting much good research. An example of an industry institute is the French Petroleum Institute (Institut Français du Petrole), which is supported by the petroleum producers and refiners and by a portion of the gasoline tax. It functions as a research association laboratory, as an industry school and, much less frequently, as a service to individual companies. There exists in France a government contract research institute known as the National Institute of Applied Chemical Research (Institut National de la Recherche Chimique Appliquée), which is under the direction of the Ministry of Industries and Commerce. It has a total staff of about 150 and is aided financially by partial government support.

Two scientists who played an important part in the establishment of the French Petroleum Institute combined that experience with their knowledge of the American research institutes and consulting firms to form ERSI (Etudes et Recherches Scientifiques et Industrielles), with offices and laboratories in Paris. As would be expected, this firm conducts research, does consulting, and performs engineering services by contract, primarily in the fields of chemical engineering and chemistry. In many respects its scope and function are similar to those of the Topsöe Laboratories in Copenhagen, Denmark, which have to their credit some important achievements in the development and manufacture of catalysts. Perhaps the leading organization serving Danish industry is ATV, or the Academy of Technical Sciences (Akademiet for de Tekniske Videnskaber), which was formed twenty years ago. ATV consists of about seventeen industrial associations which coordinate research undertaken on the basis of submitted suggestions. The annual budget is 5 million kroner. It includes the Danish Technical Information Service.

Fulmer Research Institute, Slough, Bucks, England

ITALY

An example drawn from Italy is the research organization of the nationalized petroleum industry usually spoken of as E.N.I. (Ente Nazionale Idrocarburi). Located at San Donato, near Milan, is the new research laboratory with its cosmopolitan staff of specialists, all in the broad field of petroleum technology. Services are primarily for E.N.I., but it is intended that other groups can have certain studies made by the laboratory if the results tend to further the production and consumption of petroleum and its products in Italy.

SWITZERLAND

Associated with the Zurich Technical University (Eidgenössische Technische Hochschule) in Switzerland is a small institute known as the Industrial Research Section of the Institute

Battelle Institut e.V., Frankfurt am Main, Germany.

* The professor institutes are university groups dealing with rather specific disciplines, usually under the leadership of a professor who has become an authority on the subject. Such institutes perform research by contract but generally prefer strictly basic problems.

of Technical Physics (Abteilung für Industrielle Forschung des Instituts für Technische Physik der Eidgenössischen Technischen Hochschule). It is roughly analogous to a university research foundation in the United States, and has some full-time staff members. Its research for various industries has made it well known and highly respected.

NORWAY

Norway is a country of 3½ million people with rather few diverse and widely scattered industries. It is unthinkable that an independent research institute could exist in that country. It would be difficult for all of Norway's more important industries to staff and equip themselves for their own research. Accordingly, under the aegis of the Royal Norwegian Council for Scientific and Industrial Research (Norges Teknisk-Naturvitenskapelige Forskningsrad), the Central Institute for Industrial Research (Sentralinstitutt for Industrial Forskning), has been established at Blindern, a suburb of Oslo, in association with the University. It consists of several specialized institutes doing research more as the association laboratories in Great Britain do for whole industries, but with provision for specific projects for individual companies. It will be seen that independence as well as integration of disciplines, generally thought of as advantages found in the research institute, are not emphasized at Blindern. In a comparatively small industrial economy such as that of Norway, however, this type of compromise appears to be necessary. At Trondheim there is S.I.N.T.E.F. (Selskapet for Industriell of Teknisk Forskning), which appears to be like an American university research foundation as it utilizes some of the staff at the technical college as well as some of its own. In Bergen, Chr. Michelsens Institute has had, since the end of the war, a department which accepts sponsored research problems. Its present staff is now approximately 40.

General Conclusion

As is the case in the United States, a great deal of the contract research in Europe is sponsored by the larger companies. There, as well as here, there is a crying need for the development of improved attitude toward, and acceptance of, things that are new. The benefits of research, whether done by a company, or done for it by a contractor, must be realized by many more firms in the future. The contract research institutes for many years have had an educational function as well as a research function. They have contributed to the widespread knowledge of scientific research in this country. It is to be hoped that they will not only do this in Europe, but also will increase international understanding among scientists and engineers, an understanding which should spread to others in this geographic area which is so different from the United States but which is populated by people with similar hopes and ambitions: to live in reasonable comfort, to provide peace for subsequent generations, and to maintain and increase the dignity of man.

SWEDEN

Sweden has somewhat the same arrangement as Norway; several of the institutes, including that for atomic energy, are found at the Royal Institute of Technology in Stockholm (Kungliga Svenska Vetenskapsakademien). An independent and rather highly specialized group conducting sponsored research is the Semiconducter Institute (Institutet för Halvledarforskning), which has a staff of about 40 and is located in Stockholm also.

HOLLAND

In Holland there is a group of important research laboratories best known to Americans as TNO (Organisatie voor Toegepast-Natuurwetenschappelijk Ongerzoek). With considerable government assistance, with contributions from industry, and with some direct project financing, the institutes of TNO cover the important scientific and engineering areas for Holland.

EUROPEAN NUCLEAR RESEARCH CENTER

Brief reviews of selected European research establishments should not be concluded without reference to C.E.R.N. (Centre Europeen de la Recherche Nucleaire). Although it is somewhat removed from chemical research, this group of more than 200 research scientists is pioneering in basic nuclear research through international cooperation. Twelve nations are contributing both money and direction to C.E.R.N. with the understanding that the research results will be freely publishable. A nuclear reactor is not contemplated. C.E.R.N. is located in the western suburbs of Geneva, Switzerland, within a few feet of the French border.

Battelle in Geneva and Frankfurt

The continued absence of independent research institutes on the Continent even in 1950, coupled with continued requests from that area for the services of Battelle Institute, made necessary a serious consideration of the desirability of placing a laboratory there. Careful studies led to the conclusion that Battelle Institute would be welcomed, especially if located in a place known to be international. With the choice so narrowed, it is not surprising that Geneva was selected. The city, the Canton, and the Federal Government were receptive to the idea, an excellent piece of land was obtained, and the construction of a laboratory was begun. It is now a widely admired laboratory building of 40,000 sq.ft., with a near-by house adding space for a library, conference rooms, and business offices. The staff now numbers 207. A second laboratory similar in size to the first is currently being built as a result of industry's demand for more research.

In the course of further studies, however, the industry of the German Federal Republic insisted that there should also be a Battelle laboratory in that country. The emphasis of that feeling became apparent when two cities offered to donate the land while the German State Bank gave permission to use blocked marks for the capital investments. The result is a group of four connected buildings at the outskirts of Frankfurt, laboratories with a total floor space of 200,000 sq.ft. and a staff of 399.

These laboratories, whose first sponsored projects were started three and four years ago, are now functioning without operating subsidy. They are clear evidence of the appropriateness of contract research for Europe. Together, these laboratories have done $1,840,000 of sponsored research during the last year for some of Europe's best known firms as well as for individuals and for companies of small and medium size. They are filling an important need of which European industry has rapidly become aware. This American procedure for supplying research services was at first greeted with some suspicion by a small minority. When Battelle's actions over several years demonstrated that scientific and industrial secrets would not be stolen and that scientists and engineers would not be recruited for work in North America, expressions of suspicion stopped. Industry's feeling of confidence was still further increased by the make-up of the staff, which is practically 100 per cent European, with no Americans, but with one member from as far away as the Portuguese colony of Macao.

Future of Contract Research in Europe

If contract research began in the United States as a phenomenon of a highly industrialized economy which was acutely aware of the value of

scientific research, it could be assumed that there was a place for it in Europe. This proved to be true, but what is its future there now? Since 1946, and especially since 1948, when currency reform occurred in Germany, the reconstruction of Europe's research effort has been rapid and effective. In 1956 annual sales of Farbwerke Hoechst were more than 16 per cent greater than in 1955. During the five years of the new company's existence, the equivalent of $200 million has been invested in new plant, while the labor force has doubled to a figure of 40,000. In 1956 the amount invested in research and development was $20 million, which is more than 5 per cent of annual sales. The company has about 1,600 scientifically or technically trained employees who are largely responsible for 20 per cent of its current annual sales resulting from products not marketed five years ago. Ciba of Basle, Switzerland, found that during the last ten years its research has increased by 120 per cent, now being only slightly less than 5 per cent of annual sales.

It is estimated that industrial and government research in West Germany totals about DM1¼ billion, which includes essentially no military investigations. This amounts to about one per cent of national income, compared with a figure of one and one-half per cent in the United States. In the United Kingdom research and development is said to total £325 million, which corresponds to 1.8 per cent of national income. If the American research level is satisfactory by this criterion, it might be said that the levels in Germany and the United Kingdom are commendably high.

Realizing the hazards of speaking in terms of research quantity alone, it could be observed that the one per cent figure for Germany might well be doubled to the nation's advantage. It is equally hazardous to use national income or annual sales as measures of research effort. Just as the pharmaceutical industry needs to invest more of its income in research than the solid fuel industry does, so is it very clear that an insular nation such as the United Kingdom needs to do an unusually large quantity of research of particularly high quality. With nearly half of its food imported and with limited workable mineral deposits, it becomes evident that Britain's major resources are the brains and hands of its people. The exports leading to the importation of essentials can be achieved by depressing wages or by increasing productivity and improving quality. Adequate research can help in bringing the United Kingdom along the latter path with an improved standard of living as a valuable by-product. This is true of almost any country, but particularly so for one which is so dependent on imports (and, consequently, on exports) for its survival.

Now that European industry has accepted the idea of contract research by independent laboratories, a measure of its future might be reached by the following rough estimates. There are usually considered to be about ten major independent contract research institutes in the United States. In 1956 they probably did about $80 million of sponsored work, this being about 0.02 per cent of America's national income. The similarity of the ratio of total research effort to national income in the United States, Germany, and the United Kingdom suggests that the 0.02 per cent figure can be extended to other countries. Accordingly, it might be guessed that the United Kingdom would soon have a need for $10 million (£3.5 million) of contract research annually, while the figure for Germany could be $6 million (DM25 million), the services in both cases being those of the independent institutes. Similar requirements will be voiced by other European countries as the value of contract research becomes more generally understood.

International Division, Battelle Memorial Institute, Geneva-Caroute, Switzerland.

The reasons why European firms turn to contract research are undoubtedly the same as in the United States. When a company is conducting research itself, it may want to expand its effort with the aid of outside agencies. It may also want to use special abilities temporarily or until the value of a particular field can be proved to management. At other times, it may certainly be that a fresh point of view is needed. It is at these times that contract research is called for, whether in the United States or in Europe. This is recognized by the smaller companies to a degree, but especially by those who have known research well. A continual program of education is necessary. It will be forthcoming in Europe as it has in this country.

Presented at A.I.Ch.E. meeting, Chicago, Illinois.

Sondes Place Research Institute, Dorking, Surrey, England.

CONSUMERS

—the chemical industry's future

The chemical industry is known as a growth industry, but the question is beginning to arise as to how much longer this growth can persist. It may be suggested that the industry is reaching maturity and can be expected to follow a very common growth pattern of some chemical commodities, which is characterized by rapid growth in the early stages, followed by a marked leveling off in later years. Almost equally common, however, is a growth pattern which year after year increases at a rate in the neighborhood of ten per cent. Obviously the question concerning future growth of the chemical industry resolves into which of the "typical" growth patterns it will follow. There are two ways in which the chemical industry can maintain a growth rate which is faster than that of the economy as a whole:

- **Successful technological competition against other raw materials and intermediate products (rayon and nylon vs. cotton, plastics vs. wood, synthetic vs. natural rubber, etc.)**
- **Capturing an increasing share of the consumer dollar by serving as suppliers to industries which are increasing their share of the consumer dollar, or by directly entering growing consumer expenditure areas (such as medicines).**

The chemical industry grew at a rate of 8 to 10%/yr. compared with personal consumption expenditures which increased at an average rate of 5.4%/yr. over the period between 1947 and 1956. The question naturally arises as to how much of this success was due to the introduction of new products coupled with the displacement of other materials by chemical products (technological competition), and how much resulted from supplying fast-growing consumer industries. It may be somewhat surprising to learn that the chemical industry *actually lost ground as a supplier of fast growing consumer industries.* Estimates based on input-output economics indicate that had there been no technological improvements between 1947 and 1956, chemicals would have grown at a rate of only 4.8 per cent—about half of their actual growth. In other words, many of those consumer products which consume appreciable quantities of chemicals are slow growing. (See Figures 1 and 2.)

The technological competition philosophy is strong in the chemical industry and is well supported by vigorous research activity. However, except for those segments of the chemical and allied products industry which directly serve consumers, insufficient attention is paid to shifts in consumer preferences. For the 65 per cent of chemicals reaching consumers through intermediate industrial channels, consumer tastes are either taken for granted or left in the hands of user-industries which are closer to the consumer. Two factors have accounted for this neglect of consumers: complexity of the channels through which consumers receive chemicals and the previous overwhelming success in technological competition.

* Mr. Strickland is editor and Mr. Carrier assistant editor of *Chemical Economics Handbook.*

Trends in consumer buying have already created difficulties in some segments of the chemical industry and presage trouble in others. Although consumer purchasing power increased 70 per cent between 1947 and 1956, the increase has by no means been allocated proportionately. Rather, an increasing share of spending is going into such areas as welfare, education, travel, and services, which, however worthy in themselves, are insignificant users of chemicals.

Consumer Behavior

Consumer trends may have varying effects on chemical companies engaged in a certain field depending on how astutely a company gauges consumer reactions both as to the technological preferences and the total level of spending. A good illustration is found in the manner in which reactions in apparel spending were reflected in the textile industry which in turn affects synthetic fibers. Although consumer purchasing power increased 70 per cent between 1947 and 1956, expenditures for clothing and accessories edged up a mere 14 per cent. The proportion of total purchasing power allocated to apparel has steadily declined, as shown in Figure 3.

As a result, over-all fiber consumption has remained stable. Rayon consumption eventually reached limits set by the inherent properties of the fiber and by consumer preferences. Some companies which capitalized on the wide acceptance of rayon eventually stagnated in rhythm with the textile industry. Early awareness of the ultimate limits to consumer acceptance of rayon led other companies to make successful long-range plans for diversi-

Fig. 1. Where chemicals go. Source: 1947 Interindustry Relations Study, Bureau of Labor Statistics.

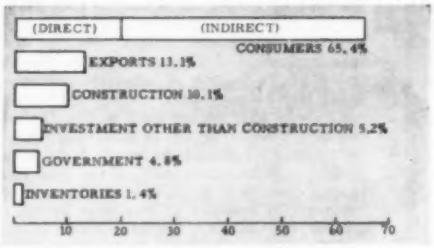
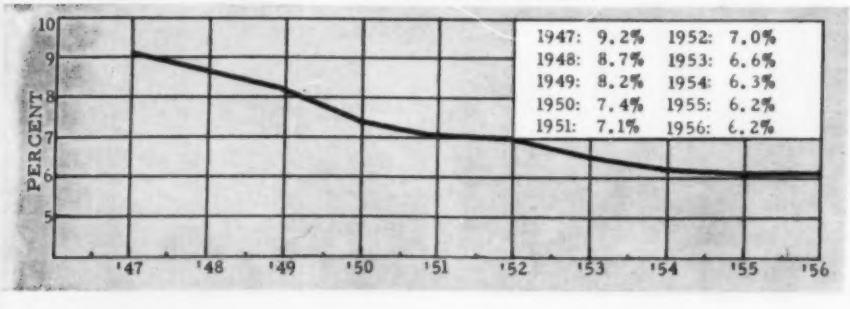


Fig. 3. Consumer expenditures on clothing and accessories (except footwear) as a per cent of disposable personal income.



John R. Strickland and Joseph E. R. Carrier | Stanford Research Institute • Menlo Park, California

fication—their operations are still growing.

There are two areas of research involved in studying the effects of consumer behavior. Of broad relevance to the *chemical industry* are such questions as:

- Which personal consumption categories require significant amounts of chemicals for their production?
- What are consumer behavior patterns in regard to specific personal consumption categories? (Amount vs. income level, etc.).

Of interest to a *specific company* are such questions as:

1. Into what personal consumption categories are their products channeled?
2. How do their products pass through these channels?
3. What factors affect consumer preferences in these areas?
   a. Quantities of a specific article which will be purchased.
   b. Factors involved in the selection of a particular type of the article in question.

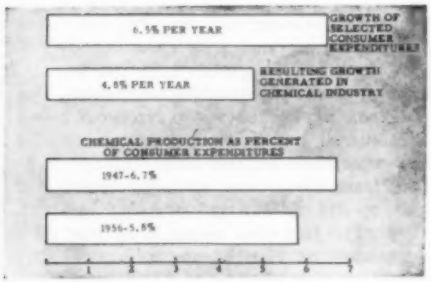


Fig. 2. Growth rate of chemical industry 1947-56 would have been lower had it not been for displacement of other intermediate products in industrial markets. Source: Interindustry Relations Study, Bureau of Labor Statistics. Selected consumer expenditures account for 70 per cent of total and were chosen from categories which could be reliably related to chemicals consumed.

Certainly some of the broad area must first be investigated to furnish guidance before engaging too deeply in investigations of a specific nature. However, it should be possible in a reasonable length of time to provide some specific guideposts for long-range company planning.

THE FUTURE GROWTH OF THE CHEMICAL INDUSTRY will be enhanced if companies supplement their technical research with economic research which takes into account the growing importance of consumer attitudes and behavior. Soft spots in the industry's future can be detected by analyzing past growth factors and considering the trends now taking place in consumer purchasing. In this latter field, research techniques now being developed can improve the coordination of long-range planning, and assist companies to realize their maximum growth potential. Most companies recognize that although the bulk of chemical shipments goes to other industries, their products must eventually reach the consumer in some form or other. In many cases these marketing channels have been well charted. The danger lies in not recognizing the degree to which slight shifts in consumer buying can cumulatively affect chemical sales over a period of years.

Stanford Research Institute has established a program of basic research supported by Institute funds for the purpose of exploring frontiers in various areas of science without thought of specific commercial application. For example, one of these Institute-sponsored projects concerned consumer behavior with respect to durable goods. The underlying purpose of this exploratory work was to determine if ownership of certain consumer durables (e.g., major household appliances) represents a pattern or "package"—that is, are certain subgroups of the general population characterized by ownership of a certain "package" of durables? The results of research to date are very promising. Preliminary evidence indicates that with knowledge of ownership of just one durable item it may be possible to predict ownership of an array of durables. For example, a pilot study of middle income families shows that ownership of a home clothes-dryer was particularly revealing. Knowing this one fact, it was possible to say with over 90 per cent accuracy that people owning a dryer also owned eight other specific durable goods.

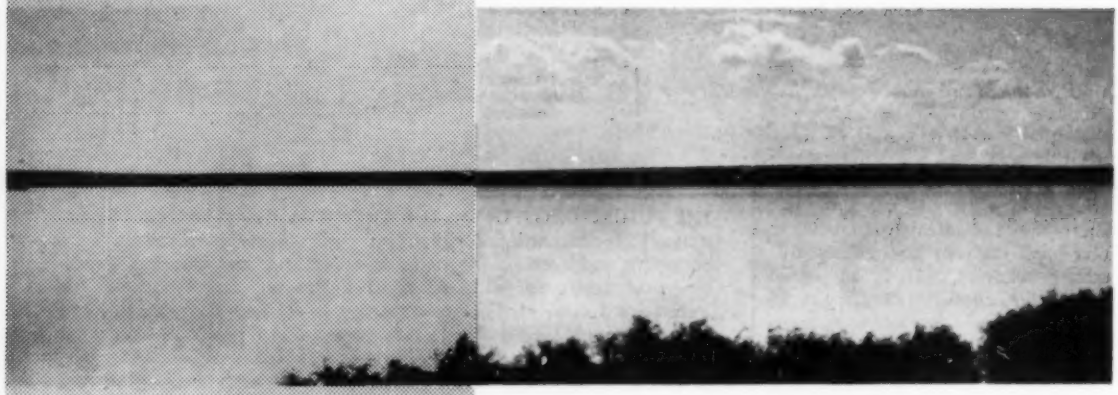
Economic Research Benefits

Consumer allocation of spending represents a long-range problem but nevertheless one which is vital to development plans for every chemical company. Successful adaptation of company planning to these trends will hinge on economic research carried out in the near future on the subject of consumer behavior and its effect on chemical companies. Some of the company activities which will benefit are:

- *Product Research*—What products, presently nonexistent, would fulfill consumer desires which are presently unsatisfied?
- *Product Development* — Indications of type of modifications result in greater consumer acceptance.
- *Sales Forecasting* — Improved forecasts resulting from detailed knowledge of consumer buying patterns.
- *Marketing and Advertising*—To what extent can consumers be influenced and motivated? To what extent should the company assume responsibility for promoting a consumer item utilizing their chemicals?
- *Finance*—Advance indications of budget trends (A significant increase in advertising may be desirable.)
- *Management*—Is the company too strongly oriented toward a vulnerable consumer category? Should diversification be considered?

One of the outstanding factors in the chemical industry's past growth has been the alertness of management in sponsoring technical research and adopting new techniques. Future years will almost certainly bring continued shifts in consumer behavior and, to the extent that companies are alert to the causes behind these shifts, they can benefit from them. It is reasonable to expect that the support of economic research programs with similar vigor will prove equally rewarding.

WATER RESERVOIR EVAPORATION CONTROL



Russell G. Dressler * Chemical Process Consultant, San Antonio, Texas

Arnold G. Johanson † Archer-Daniels-Midland Co., Minneapolis, Minn.

Savings of more than 20 billion gallons of water daily in the United States are seen possible as a result of new monomolecular film techniques for cutting down evaporation from lakes and reservoirs.

An added burden to the general arid conditions and recurrent droughts in the United States is the ever-increasing expansion of water demands due to the growing population, industries, and irrigation. This growth continues at an increasing rate. In such states as Kansas, Nebraska, Colorado, Texas, New Mexico, Arizona, California, and others in the West, a shortage of water has been a common experience.

The report by the Presidential Advisory Committee on Water Reserve Policy (December, 1955) estimated that in 1975 the United States will require a total of 350 billion gallons a day. This would be an increase of 90 per cent over that required in 1950.

Industry vs. Water

Historically, civilizations have settled and prospered where there was an abundance of water. Industry in this country is following the same trend in locating new plants with careful regard to water supplies. Also, many existing plants are searching for means of extending limited water resources.

Industrial and miscellaneous users are expected to increase their total intake from the present 60 billion gallons to 115 billion gallons daily by 1975 (*1*). Likewise, water for steam generation of electric power is expected to rise from 60 to 131 billion gallons daily.

In many of the process industries water is used for suspending, washing, condensing, or cooling operations. Water requirements of from 20,000 gal. to 200,000 gal./ton of finish d product are not unusual (*2*). The aluminum companies report that 320,000 gal. are required/ton of metal produced (*3*).

Evaporation and Monomolecular Films

Evaporation from reservoirs, especially in hot, arid climates, represents a major loss. Typical evaporation rates for a number of locations are shown in Table 1 (*4*). By applying

* R. G. Dressler is located at 204 Carolwood Drive, San Antonio 13.

† A. G. Johanson is chemical director in the Chemical Products Division.

a 0.7 factor to the Class A pan losses, one arrives at actual reservoir losses ranging from 25 to 80 in./yr. A recent review (*5*) of evaporation data indicates that actual evaporation losses are as high as 130 in./yr. in the Big Bend section of Texas.

It is possible to save a high percentage of these losses by coating a reservoir with certain organic compounds that form monomolecular films on the water surface. Compounds found most effective are the fatty alcohols, principally octadecanol (stearyl alcohol) $CH_3(CH_2)_{17}OH$; and hexadecanol (cetyl alcohol) $CH_3(CH_2)_{15}OH$. When the fatty alcohol is applied, it spreads to form a continuous, protective surface coating.

Monomolecular Film Research

HISTORY

The phenomenon of film-forming abilities of organic compounds was observed in 1899, but the first attempts to use films to retard evaporation were not undertaken until 1924. These were not successful. The first successful results were obtained in 1927. With the use of hexadecanol films, a 50 per cent reduction in the rate of evaporation was reported. In 1939 the use of a mineral oil film was patented, but the process did not appear promising for bodies of water used for domestic purposes, especially drinking water and water areas selected for recreational purposes.

W. W. Mansfield of the Commonwealth Scientific and Industrial Research Organization of Australia initiated in 1952 the first outdoor trials. The publication (*6*) of his results was received with much interest in the U.S. At the First International Conference on Reservoir Evaporation Control at San Antonio, Texas, in April, 1956, Mansfield presented a summary of three years' work, including the results of trials on reservoirs of 2- to 22-acre size. The trials involved principally the use of floats containing solid fatty alcohol; the results varied from 0 to 90% saving of water.

Studies by La Mer (*7, 8*) and his co-workers on the physical chemistry of monomolecular films should be recognized.

The U.S. Bureau of Reclamation, Division of Engineering Laboratories, Denver, Colorado, has made indoor and outdoor trials. Results from these evaporation pan studies confirm those of others and show savings which range from 45-64%. Especially is recognition due for their fundamental studies on factors affecting film-spreading rates, film life, and film detection techniques. As a continuation of their indoor studies on biological effects, a test has been made on a 6-acre isolated bay of Lake Hefner, Oklahoma City, with favorable results.

Other workers are the U.S. Geological Survey at Denver, the Southwest Research Institute at San Antonio, and the East African Meteorological Department at Nairobi, Africa. Few technical papers on the subject have been published by U.S. researchers. An article by Dressler (*9*) summarizes the development of the art.

The Archer-Daniels-Midland Company of Minneapolis, Minnesota, has been active in reservoir evaporation control research and is a supplier of fatty alcohol products especially prepared for water evaporation control use.

THEORY OF ACTION

Fatty acids and fatty alcohols of C_{12}—C_{20} carbon chain length are typical of the monomolecular film materials. The compounds vary from liquid to solid materials of melting points approximately 20-60° C. These compounds have in their configuration an OH (hydroxyl) group. This group, being identical to such a group contained in the water molecule, stimulates an affinity between one end of the molecule and the surface water molecules. One theory suggests the alignment of the fatty film molecules, standing on end perpendicular to the water surface. This closely packed alignment has the effect of hindering the escape of water vapor, and thus, reducing evaporation.

FILM CHARACTERISTICS

It is important to realize that a monomolecular film has a thickness of one molecule, which is one ten-millionth of an inch. This is contrasted with a mineral oil film on water, for example, which may be 50 or more molecules deep and has entirely different characteristics. The monomolecular films do not interfere with oxygen and carbon dioxide transfer between water and air. Preliminary results of both laboratory and outdoor trials by the Bureau of Reclamation and other sources indicate that alcohol monomolecular films have no adverse effect on fish, aquatic plants, or wild fowl. The U.S. Public Health Service has pointed out that the materials themselves are of a low order of toxicity and that no hazard to health would be anticipated in their use.

Examining experimental equipment used in water evaporation control tests.

DETECTION OF FILM COVERAGE

During the application of fatty alcohol films for water evaporation control, it is important to know positively that film coverage is present. Several techniques for film detection have been developed. Following, in brief, are three of the methods:

- A pinch of camphor is dropped on the water surface from a spatula. If the camphor "dances," no film is present. If the camphor is still, the test is positive.
- A pinch of finely powdered fatty alcohol is placed on the water's surface. If the powder disperses outward rapidly, there is no film. If the material remains where it is placed, there is film coverage. (A single drop of finely divided alcohol in water suspension may be used in similar fashion).
- An exact "differential film pressure" technique has been developed by the U.S. Bureau of Reclamation in Denver. By the use of a variety of indicator agents with carefully selected surface tension effects, it is possible to determine not only the presence of the alcohol monolayer, but also its pressure and the resulting "theoretical effectiveness."

Application Methods

Film application methods under development fall into two classifications: (a) utilization of floats containing fatty alcohol particles, and (b) continuous application of a fluid containing the fatty alcohol.

(a) *Float Method.* The float method, at best, is believed to be limited to water surface areas of a size up to two acres. This method uses buoyant, screen-covered floats filled with active material in granular or flake form to present a large surface area. These floats are anchored at spaced intervals on the pond surface and are expected to replenish the film losses due to solubility, wave action, etc., as required.

Several of the research groups in the U.S. have deferred further work on the float method. It appears that the rate of dispersion of the film from the fatty alcohol particles is not rapid enough to maintain a continuous coverage under windy conditions or on other than small ponds (i.e., maximum 1/5 acre). However, some research continues currently, and several improvements have been suggested to provide the required fatty alcohol surface area for satisfactory coverage.

(b) *Continuous Application Method.* For large reservoirs the float method would be cumbersome, even if applicable. Floats would be difficult to anchor and maintain in deep water and would offer serious interference to the pursuance of recreational activities and the like. Moreover, it has been found that on large bodies of water even an excessive number of floats does not generate film at a sufficient rate. A method is required which will assure a rapid dispersion of film. Such a method has been developed and has been tested on various reservoirs with surface areas of 2 acres, 50 acres, and 330 acres. The method, known as the "suspension process," applies the active material in the form of a stabilized aqueous suspension. The fatty alcohol is in finely divided state, presenting a large total surface, and is capable of forming a film instantaneously. With this method a film can be maintained on a reservoir continuously and with control.

A series of experimental trials has been completed on a 50-acre reservoir near Eagle Pass, Texas. In these tests complete scientific data were taken on the weather and reservoir conditions, along with companion data on a U.S. Weather Bureau 4-ft. evaporation pan installed at the site.

The meteorological conditions existing along the Mexican border in July are interesting. Typical daily air temperatures were around 100-103° F., reservoir water surface temperatures 85° F., humidities at mid-day 18-30%, and wind velocities 6-15 miles/hr. The normal evaporation loss under these conditions is in excess of 0.5 in./24 hr.

After applying films to the 50-acre reservoir with the use of the suspension process, evaporation was reduced 30-40%. These were preliminary trials, for 10-12 hr. periods. It is expected that in future trials higher savings will result, over long periods of time, due to the use of improved equipment that applies the active material more uniformly. Similar trials on a 2-acre reservoir, with better control, gave savings over 60%.

Preliminary Estimate of Cost of Saving Water

(a) COST OF FATTY ALCOHOL

From the studies made on reservoirs from 2- to 330-acre size, much information has been obtained on the application rates required, the efficiencies, and the mechanical aspects of the application of films. The application rates required under various weather conditions have been determined.

Example

A reservoir rectangular in shape, of a size 1 mile × 4 miles—apply the fatty alcohol suspension at an average rate of 105 lb. fatty alcohol/24 hr. To cover the reservoir for six months during the summer, i.e., 180 days, would require 180 × 105 lb. = 18,900 lb. fatty alcohol. At $0.60 lb., the cost would be $11,340.

Take an evaporation loss (avg. of twenty-one western locations) of 48 in./yr. Studies show that the six months of summer represent about 70% of the year's evaporation loss. Therefore, the six months of summer represent 0.70 × 48 in. = 33.6 in. The 1- × 4-mile area is 2,560 acres, and the normal evaporation loss would be 33.6/12 × 2,560 = 7,160 acre/ft. If the film application saves 40%, the total water saved would be 2,864 acre-ft., and the cost of the film-forming material is $11,340/2,864 = $3.96/acre ft. water saved (1.2¢/1,000 gal.).

On larger reservoirs the unit cost would be correspondingly lower for a constant application rate because of more extensive coverage.

(b) COST OF EQUIPMENT

The equipment required for application would consist of supply tank, pump and lines, and electrical wiring. The total cost of this equipment installed is estimated preliminarily at $3,600/station. Amortized over five years for the 2,864 acre-ft./yr., the cost is $0.25/acre-ft. of water saved.

(c) LABOR AND POWER

Labor would consist of one operator to mix the suspension, to distribute it by hose truck to the supply tanks, and to regulate the application. One operator could service ten application stations. Assume six months @ $400.00 month = $2,400/10 stations × 2,864 = $0.08/acre-ft. Power would be $1.50/day/station or $270/six months = $0.09/acre-ft. Maintenance of equipment and miscellaneous may amount to $50 month/station = $300/six months = $0.10/acre-ft. Site surveys, consulting, and engineering may cost $500/station. This, when amortized over five years, becomes $500/5 × 2,864 = $0.04/acre-ft.

(d) TOTAL COST

The total cost of saving water is shown in Table 2. This amounts to $4.52/acre-ft., which is equivalent to 1.4¢/1,000 gal. Such low figures are of great interest in view of the current values of irrigation water at about $6.00/acre-ft. and municipal reservoir water at $10-$40/acre-ft.

Predictions

The promise of a practical and economical method for use on water reservoirs is commanding much attention by water users, such as the process industries, irrigation districts, and reservoir operators.

A Geological Survey paper (*10*) lists 1,300 major reservoirs and lakes in the U.S., totaling 11,046,000 acres of surface. At a possible average saving of 1½ vertical ft./yr., this would represent a potential gain of 14.7 billion gal./day. Other unlisted and private reservoirs, lakes, and ponds might account for an additional 50% of surface. In this case, the total ultimate

Table 2.—Summary of Operating Costs

Item	Cost/acre ft. water saved	% of total cost
Fatty alcohol	$3.96	88
Amort. of equip.	0.25	5
Maint. & misc.	0.10	2
Power	0.09	2
Labor	0.08	2
Consulting, engineering	0.04	1
Totals	$4.52	100

savings could make more than 20 billion gallons additional water available daily. This is an appreciable percentage of present industrial water usage.

Future work on the engineering application of monomolecular films will be directed to the further demonstration of the process, to the confirmation of results, and to the determination of maximum water savings possible over longer periods. On smaller reservoirs, it has already been shown that savings in the range of 30-60% can be achieved, duplicating those obtained heretofore only in laboratory or evaporation pan experiments. The engineering and cost studies will continue.

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Presented at A.I.Ch.E. meeting, Chicago, Illinois.

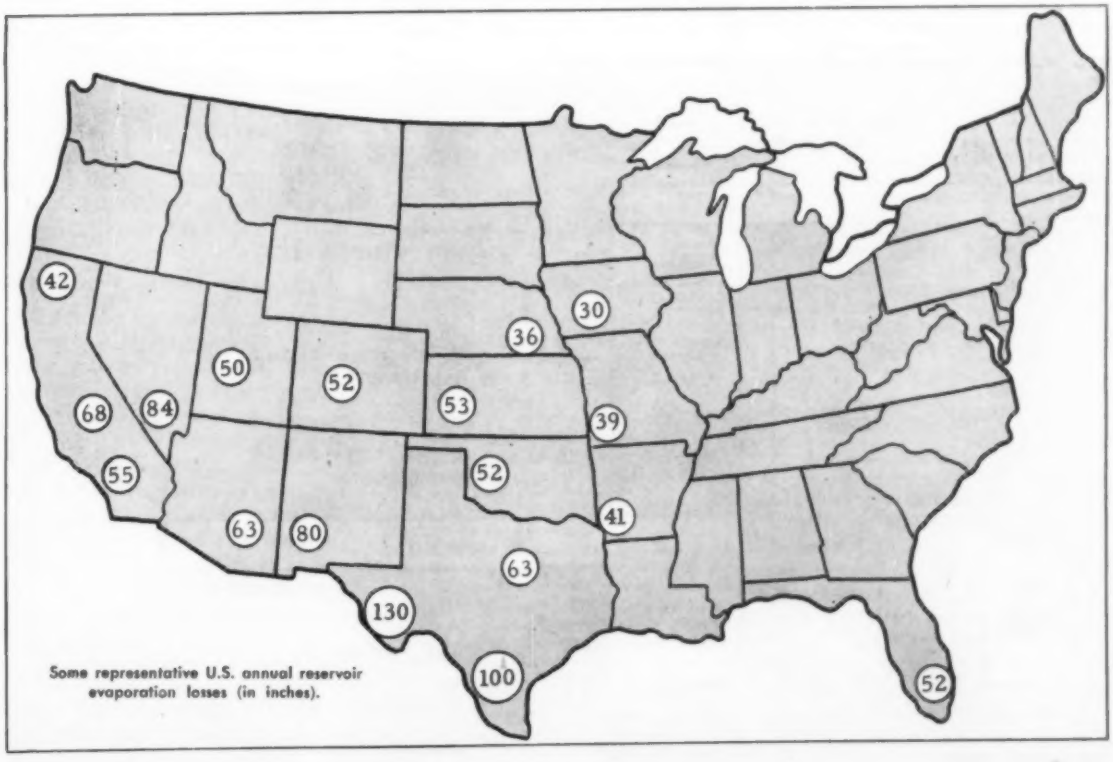
EVAPORATION CONTROL

Table 1.—Typical Evaporation Rates

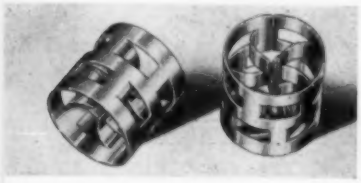
		Observation period (months)	(Avg. evap. rate (Class A pan) in.	Gal. lost/ Acre of Surface * (thousands)
Arkansas	Hope	12	59	1,020
	Russellville	12	53	1,010
Colorado	Montrose	12	56	1,060
	Pueblo †	11	75	1,420
Iowa	Ames	7	43	815
	Norwich	7	48	910
Kansas	Hays	7	76	1,440
	Wichita	7	55	1,040
Missouri	Columbia	8	37	700
	Lakeside	12	55	1,040
Nebraska	Bridgeport	7	44	835
	Lincoln	7	52	985
New Mexico	Caballo Dam	12	114	2,160
	Portales	12	91	1,725
	Roswell	12	75	1,420
Oklahoma	Norman	9	51	965
	Tipton	9	77	1,460
	Woodward	10	58	1,090
Texas	Austin	12	67	1,270
	Dilley	12	78	1,480
	Ysleta	12	99	1,870

* Water loss figures have been adjusted by use of conversion factor 0.7 to convert annual pan evaporation to actual loss from lakes and reservoirs, and then converted to gal. lost/acre/yr.

† Pueblo, Colorado (listed above), has a Class A pan evaporation of 75 in./yr., equivalent to 52.5 in./yr. actual loss. By treating a reservoir at this location with a film, and reducing evaporation by, say, 50%, the saving would be 710,000 gal. water/acre/yr.



Some representative U.S. annual reservoir evaporation losses (in inches).



PALL RINGS—new type of tower

Results of comparative tower packing performance tests of carbon steel Pall rings and Raschig rings of same size indicate improved mass transfer coefficients and reduced pressure drop for Pall rings. This efficiency is attributed to increased utilization of the inside surface of the ring, decreased tendency to channel, and increased permeability.

John S. Eckert, Earl H. Foote, and Richard L. Huntington *

The United States Stoneware Company
Akron, Ohio

The Pall ring has the same outward form as the Raschig ring, the height and the diameter being equal. However, it is stamped during the forming operation so that it has projections bent inward. This opens the ring and results in a packing which gives a marked decrease in liquid channeling and migration with a consequent increase in packing surface utilization. The pressure drop is decreased by the increased permeability.

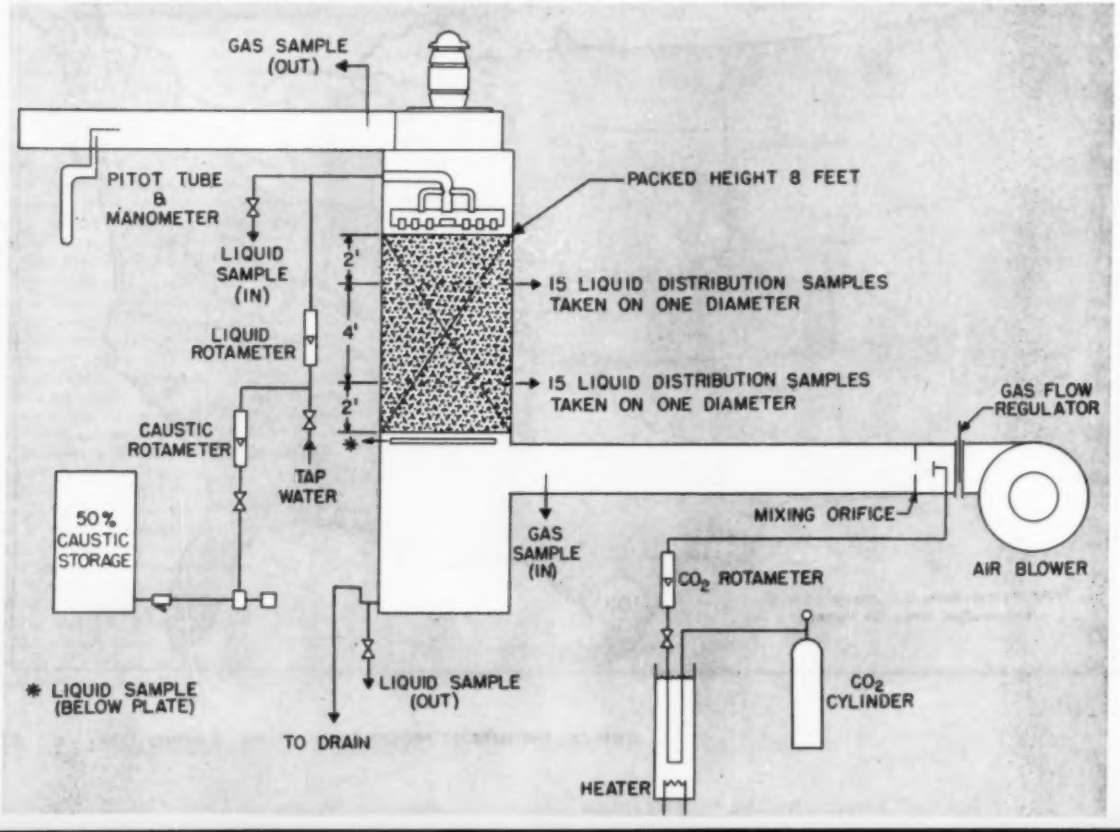
* J. S. Eckert is chief engineer, E. H. Foote, design engineer, and R. L. Huntington, development engineer.

This paper deals with carbon steel Pall and Raschig rings. Distillation tests conducted by Pfannmuller (*1*) indicate that Pall rings give less than half the pressure drop, less entrainment, lower height equivalent to theoretical plate and a higher boil-up rate without impairment of fractionating efficiency.

Features of the Pall Ring

- The Pall ring, having equal diameter and height, retains the advantage of the Raschig ring in that it assumes a random position in the tower.

Fig. 1. Schematic diagram of 30-in. diam. experimental absorption tower.



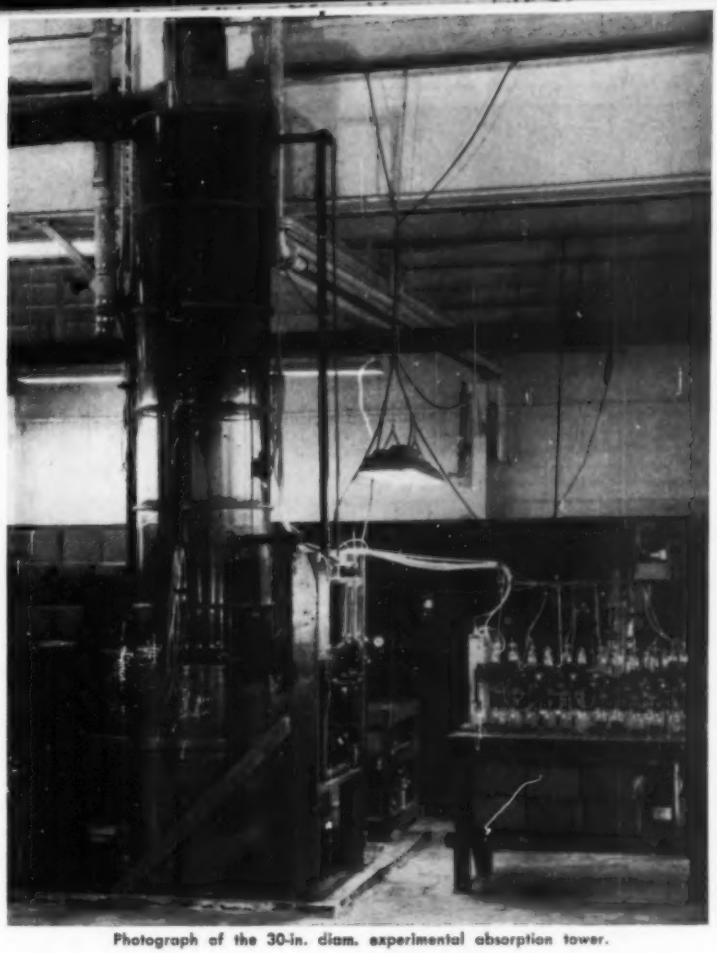
packing

History

Tower packing has been the object of invention since the days of the coke-packed tower. The Raschig ring, one of the earliest developments, remains today as one of the standards, largely because it is structurally strong and because it has high void space. It possesses certain disadvantages in that irrigation liquid shows a marked tendency to channel and to migrate, especially to the tower walls with a resultant decrease in capacity and the necessity of frequent liquid redistribution in deep beds. The pressure drop is also appreciable.

Then came the modified rings, such as the Lessing ring, the cross-partition ring and the spiral-type rings, all of which gave greater surface area for gas-liquid contact. Berl saddles reduced somewhat the tendency toward channeling. Intalox saddles further improved surface utilization and also gave a lower pressure drop.

About ten years ago the Pall ring was developed by Badische Anilin and Soda-Fabrik in Ludwigshafen-am-Rhein, Germany. It found immediate acceptance in Europe and is produced in both ceramic and metal shapes in Germany.



Photograph of the 30-in. diam. experimental absorption tower.

- Having the cylinder wall 35% open, it has high permeability.
- Its projections serve to utilize the interior of the ring for gas-liquid contact.
- The projections nearly touch in the center and therefore, allow smooth flow of liquid.

Objectives of the Tests

The immediate purpose of the tests was to accumulate gas mass transfer coefficients and pressure drop data on Pall rings and related packing in a commercial-sized tower so that the data would be of value in commercial design. This is part of a long-range program aimed at accumulating sufficient data to allow accurate prediction of absorption coefficients for other gas-liquid systems. Investigations were also made on the variation in liquid and gas compositions at various positions in the tower diameter.

The carbon dioxide-sodium hydroxide system was chosen primarily because of the availability of the materials, ease, and accuracy of analysis of the gas and liquid streams and also because of the amount of work already done on this system and related liquid-film controlled absorption systems by other investigators (*3, 4, 5*) which permitted a comparison of packing performance.

The tests were run in a 30-in. diam. column with a packed bed 8 ft. deep. The arrangement of equipment is shown in Figure 1.

The air to the column was supplied by two blowers. The blower on top of the column (2 hp.) was mounted in a standard position and operated under suction. The gas rate to the column was increased by means of a 5-hp. booster fan on the inlet to the base of the column which operated under a back pressure.

The air rate was measured by means of a pitot tube in conjunction with a differential manometer. The pitot tube was mounted in the outlet duct of the column. The air flow was controlled by means of a gate valve on the outlet of the booster fan at the base of the column.

The carbon dioxide was supplied to the air inlet from carbon dioxide cylinders. The carbon dioxide was warmed to room temperature by means of an oil bath electric heater and metered through a standard gas rotameter. The carbon dioxide was introduced into the tower inlet duct and thoroughly mixed with the air by passing through a mixing orifice.

The 50% sodium hydroxide and water were metered through rotameters and mixed by passing through the inlet pipe to the tower distributor.

Provisions were made for obtaining simultaneous liquid and gas samples across the packed bed diameter at points one fourth and three fourths of bed height. Samples of liquid and gas were taken at the inlet, outlet, and below the bed support plate by means of a liquid and gas by-pass system. The by-pass system was used to decrease sample line hold-up.

The liquid sample below the support plate was obtained from an angle iron trough which crossed the tower diameter and was inclined at such an angle that the excess liquid was continually drained from the trough. A sample of this composite was removed by means of a ¼-in. pipe communicating with the outside of the tower.

Procedures

TESTING

The tower was packed by hand to a total bed depth of 8 ft. The weir flow distributor was then put in place and adjusted to a level position with a spirit level. Each of the thirty distribution points was then checked for flow at a liquid rate of 300 lb./(hr.)(sq.ft.). The new packing was washed repeatedly with a strong detergent solution until all traces of oil were removed. The packing was then thoroughly rinsed and given an added

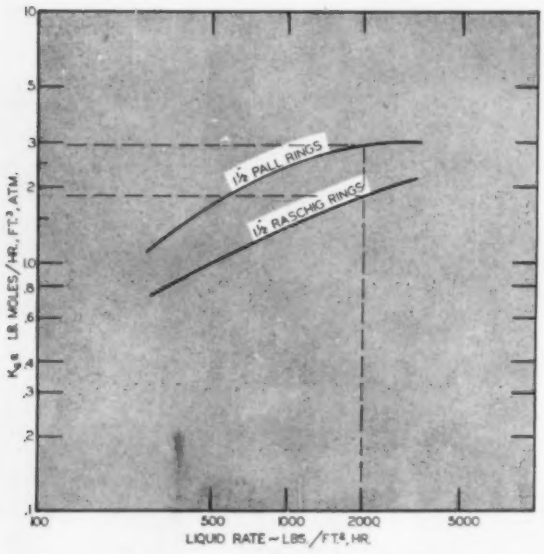


Fig. 3. K_Ga vs. liquid rates, 1½-in. rings. Gas rate: 450 lb./(hr.)(sq.ft.). Liquid concentration: 4% NaOH.

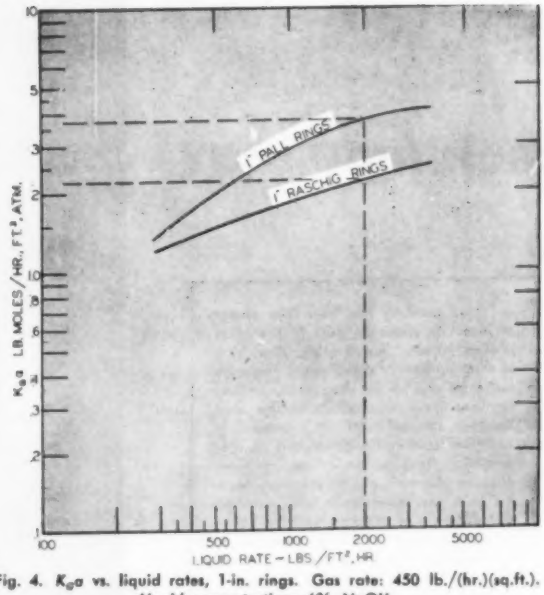


Fig. 4. K_Ga vs. liquid rates, 1-in. rings. Gas rate: 450 lb./(hr.)(sq.ft.). Liquid concentration: 4% NaOH.

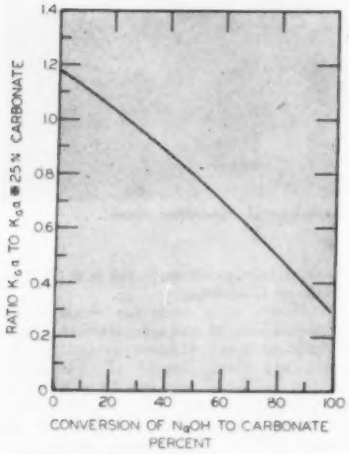
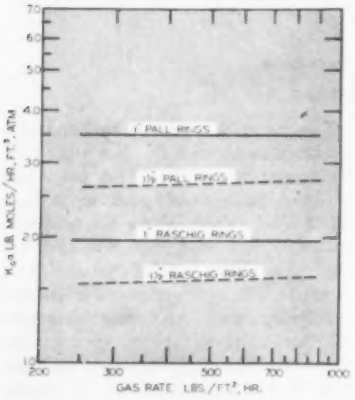


Fig. 2. Effect of carbonate on K_Ga.

Fig. 6. K_Ga vs. gas rate, 1- and 1½-in. rings. Liquid rate: 1,500 lb./(hr.)(sq.ft.).



rinse with inhibited acid solution to remove any rust present and also to etch the metal surface. After each set of runs the packing when idle, was rinsed with strong sodium hydroxide solution and dried to prevent rust formation on the packing.

OPERATING

The packing prior to each set of runs was thoroughly rinsed and given an added acid rinse if the packing had been idle for a good length of time. The gas rate was then adjusted to the desired conditions and a corresponding carbon dioxide flow was set to give a carbon dioxide concentration of approximately 1%. The oil bath electric heater was adjusted by means of a powerstat to give a carbon dioxide temperature corresponding to room temperature. The temperature at the inlet and outlet of the carbon dioxide rotameter was recorded for correction of gas flow measurements. The sodium hydroxide flow was adjusted in accordance with water flow to give a sodium hydroxide concentration of 4%, or 1 N. The normality of the sodium hydroxide solution was then checked by analysis of the outlet from the base of the tower. A period of at least 15 min. was allowed for the tower to come to equilibrium before starting to take gas and liquid samples. A constant check was made on gas and liquid flows to insure that the conditions did not vary during the equilibrium time and the sample time. The samples were obtained over a period of at least 15 min. The liquid in the gas sample bottles was replaced with sample gas at a uniform rate by throttling the stopcocks at the inlet of the sample bottle. The liquid in the gas sample bottles was kept acid and so indicated by methyl orange indicator to prevent any carbon dioxide absorption. The liquid solutions were stored in sealed glass bottles and covered with kerosene to blanket the liquid and prevent carbon dioxide absorption.

ANALYTICAL

The gas composition was determined by absorption of the carbon dioxide in a strong potassium hydroxide solution, with the use of a Haldane gas burette. The gas analysis obtained by means of the Haldane gas burette gave results which were reproducible to within ±3%. The liquid samples were analyzed by titration with 0.1 N HCl acid to a methyl orange end point in determination of total alkalinity and to a phenolphthalein end point, with barium chloride to precipitate the carbonate. The difference between the two titrations represented the carbon dioxide or carbonate present.

Treatment of Data

The values of gas mass transfer coefficients used in plotting the graphs given in this account were calculated as shown in Equation (1) on the basis of gas analysis, and only those runs which gave material balances to within ±10% when compared to liquid analyses were used. The gas mass transfer coefficients reported were based on over-all material balance across the tower and include the absorption occurring below the support plate.

$$K_Ga = \frac{N}{(h)(A)(\Delta P_{CO_2})} \qquad (1)$$

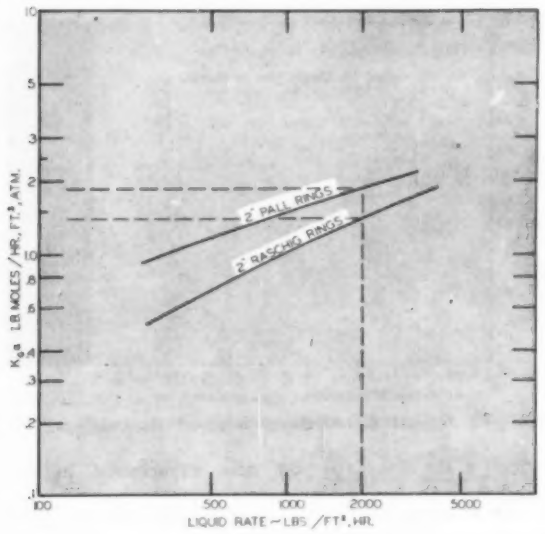


Fig. 5. K_Ga vs. liquid rates, 2-in. rings. Gas rate: 450 lb./(hr.)(sq.ft.). Liquid concentration: 4% NaOH.

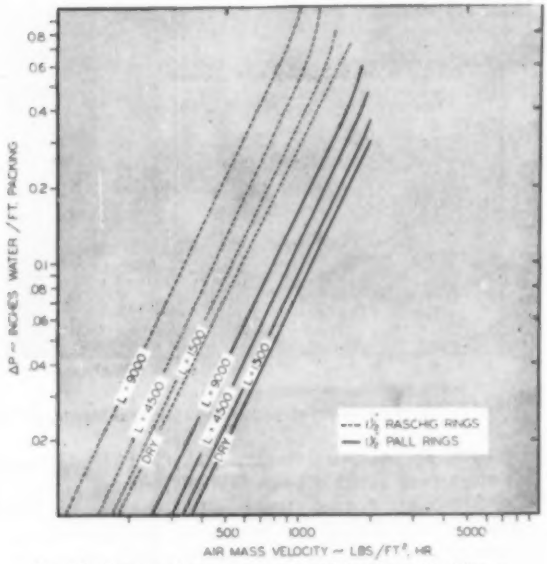


Fig. 10. Pressure drop vs. gas rate, 1½-in. rings. Liquid rate lb./(hr.)(sq.ft.) as parameter.

where

N = lb.-moles of solute gas transferred/hr.

h = packed height, ft.

A = tower cross-sectional area, sq.ft.

ΔP_{CO_2} = logarithmic mean partial pressure of solute in gas stream

K_Ga = over-all capacity coefficient, lb. - moles/(hr.) (cu. ft.) (atm.)

Note: all K_Ga are corrected for carbonate content by dividing by ratio K_Ga (actual) to K_Ga @ 25% carbonate.

The liquid and gas samples obtained below the plate gave values which indicated that an average of 5% of the absorption occurred below the plate.

All of the gas mass transfer coefficient values were corrected to a relative value of 25% sodium carbonate concentration by using the ratio obtained from Figure 2.

Discussion of Results

The gas mass transfer coefficient values obtained with Raschig rings give a curve which approximates a straight line on a log-log plot. (Figures 3, 4, and 5.) The Pall rings exhibited a much greater degree of curv-

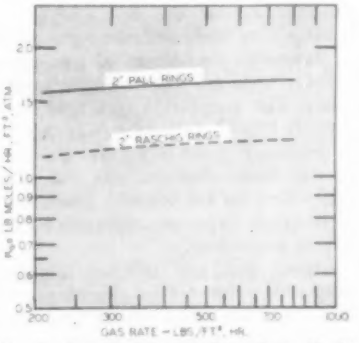


Fig. 7. K_Ga vs. gas rate, 2-in. rings. Liquid rate: 1,500 lb./(hr.)(sq.ft.).

Fig. 11. Pressure drop vs. gas rate, 1-in. rings. Liquid rate lb./(hr.)(sq.ft.) as parameter.

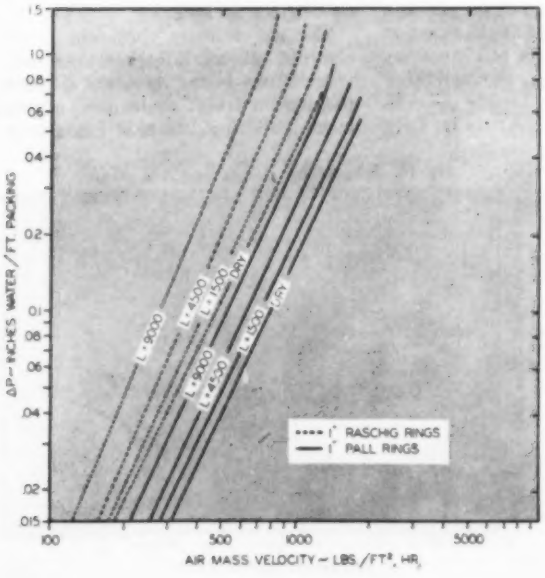
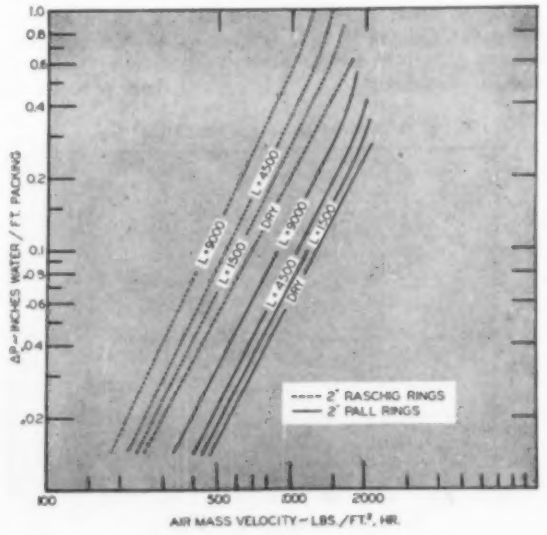


Fig. 12. Pressure drop vs. gas rate, 2-in. rings. Liquid rate lb./(hr.)(sq.ft.) as parameter.



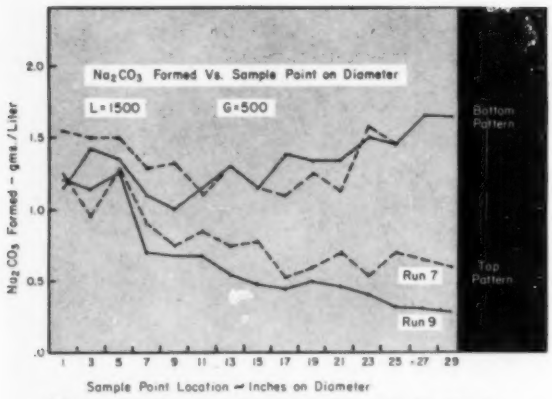


Fig. 8. Liquid concentration pattern for 1½-in. Raschig rings.

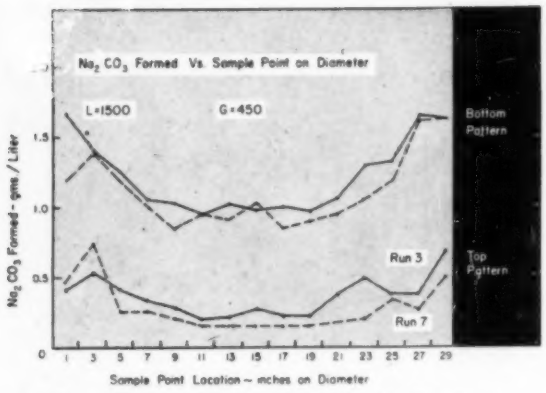


Fig. 9. Liquid concentration pattern for 1½-in. Pall rings.

ature with the relative advantages of Pall rings over Raschig rings falling off at both high- and low-liquid rates.

The 1½- and 2-in. Pall rings show a reduced advantage at high liquid rates in contrast with a reduction in advantage for 1-in. Pall rings in low-liquid rates when compared to the Raschig ring curves.

Runs were made at various gas rates to determine the effects of gas mass velocity upon gas mass transfer coefficient. The liquid rate was held constant at 1,500 lb./(hr.)(sq.ft.). A plot of the data is given in Figures 6 and 7. It was found that the gas rate had little effect on the transfer coefficient, as would be expected where the liquid film is controlling.

Liquid and gas traverse samples were taken on 1½-in. Raschig and Pall rings at a liquid rate of 1,500 lb./(hr.)(sq.ft.), Figures 8 and 9.

The irregularity of the Raschig ring liquid carbonate build-up plot, Figure 8, and the identical carbonate composition of the liquid stream at the 2- and 6-ft. level indicate that liquid and gas channeling is taking place.

The carbonate build-up plot for the Pall rings (Figure 9) was symmetrical and gives little indication of liquid and gas channeling.

The outer irrigation limit of the distributor is located at 5 and 25 in. on the diameter which is midway between the high and low values for carbonate build-up on the plot for 1½-in. Pall rings. A comparison of the liquid traverse plots indicates that the Pall rings do not redistribute the irrigation liquid to as great a degree as Raschig rings. The gas traverse analyses (not shown) did not give an indication of appreciable variation in gas composition. Variation in gas composition would not be as pronounced as liquid variation across the tower diameter because of the ease of gas mixing which was facilitated by turbulent gas flow conditions existing in the bed.

Pressure drop tests were made on the packings, results of which are shown in Figures 10, 11, and 12. The pressure drop tests were carried to the first change in the pressure drop curve corresponding to the initial loading point. It was not possible with the fan capacity available to carry the tests higher because of fan static pressure limitations. Data obtained on pressure drop was correlated to fit the equation given in Table 1 which is a summary of the pressure drop equation constants. The constants for the generalized pressure drop equation in Leva (*6*) are also summarized in that table.

The 1- and 1½-in. Pall rings gave respective pressure drops which were one fourth and one fifth of that for comparable sized Raschig rings (see Figures 13 and 14). The initial loading points are compared in Figure 15. On this graph the gas rate at the first break in the pressure drop line is plotted vs. the liquid rate. The initial loading point for 1-in. Pall rings occurs at roughly 55 to 60% higher gas rate than the initial loading point for 1-in. Raschig ring. The same comparison for 1½-in. Pall rings gives 60 to 70% higher gas rates.

GAS MASS TRANSFER COEFFICIENT COMPARISON

Inasmuch as the tower used in the evaluation of the metal packing was 30-in. diam., it is difficult to obtain data on other packing in similar towers. Most of the data available was evaluated in towers which ranged in size from 6 to 20 in. and most are also on ceramic packing.

The gas transfer coefficient values obtained are much higher than most values listed in the literature on other packings. Some evaluation of the metal Pall ring has been made in 8-

Fig. 13. Ratio of Δp vs. gas rate, 1½-in. rings.

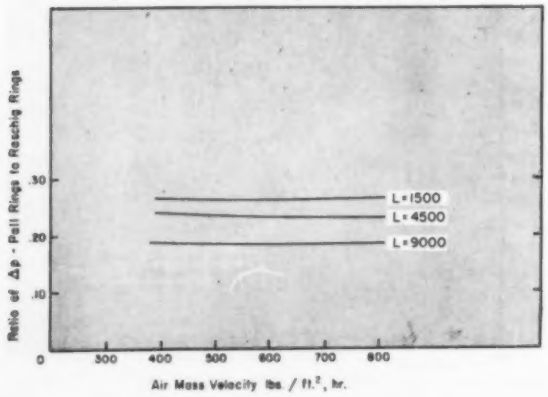


Fig. 14. Ratio of Δp vs. gas rate, 1-in. rings.

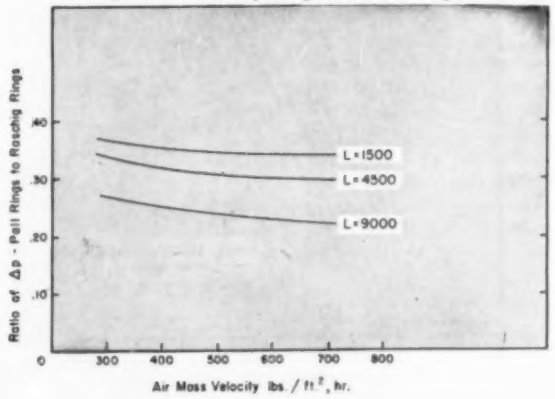


Table 1.—Constants for Pressure Drop Equations.

$$\Delta P = a 10^{\beta L} \frac{G^2}{\rho_g}$$

where: ΔP = Pressure drop, in. H_2O/ft. of packing height
G = Gas mass velocity, lb./(sec.)(sq.ft.)
ρ_g = Gas density, lb./cu.ft.
L = Liquid mass velocity, lb./(sec.)(sq.ft.)

Packing	Size in.	a Value	β Value	$\frac{a}{\epsilon^3}$
Raschig ring	1	.42	.21	115
Carbon steel	1½	.29	.20	83
	2	.23	.135	57
Pall ring	1	.15	.15	45
Carbon steel	1½	.08	.16	24
	2	.06	.12	17

Note: a/ϵ^3 is the packing factor to be used in the generalized pressure drop correlation, Fig. 19, p. 40 in Leva's "Tower Packing and Packed Tower Design."

Table 2.

Ring size in.	Liquid rate	Gas mass transfer coefficients: metal Raschig rings	metal Pall rings	Increase in gas mass transfer coefficient
1	500	1.45	2.0	38
	1,000	1.80	2.90	61
	2,000	2.20	3.70	68
	3,000	2.40	4.00	67
1½	500	1.0	1.70	70
	1,000	1.37	2.40	75
	2,000	1.82	2.90	59
	3,000	2.10	3.00	43
2	500	.71	1.15	62
	1,000	1.01	1.48	47
	2,000	1.40	1.85	32
	3,000	1.65	2.10	27

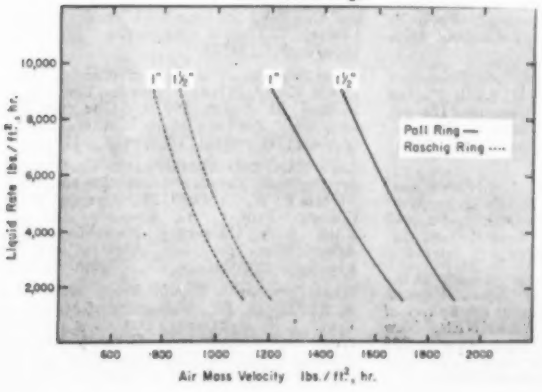
Table 3.—Physical Properties of Carbon Steel Rings.

Ring	Size in.	Wall thickness, in.	No./cu.ft.	lb./cu.ft.	Surface area sq.ft./cu.ft.	% Voidage
Raschig	1	1/16	1,345	73	56.7	85
	1½	1/16	420	50	41.2	90
	2	1/16	180	38	31.4	92
Pall	1	.0239	1,440	31	63	93.8
	1½	.0299	385	23.5	39.2	95.3
	2	.0359	175	22.9	31.2	96.4

and 12-in. towers which gave values considerably lower than in the 30-in. tower.

The gas mass transfer coefficient relationship between Pall rings and Raschig rings at various liquid rates is shown in Table 2.

Fig. 15. Liquid rate vs. gas rate at lower loading limit, 1- and 1½-in. rings.



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*The Application of Dynamic Adiabatic Calorimetry to the Copper-Nickel System from 50-620° C.** RICHARD E. PAWEL, University of Tennessee. Prof. E. E. Stansbury, 143 pp. One copy for loan from School Library. Abstract available from "Microfilm Abstracts." (1956).

*The Application of Dynamic Adiabatic Calorimetry to the Iron-Iron Carbide System from 50-950° C.** D. L. McELROY, University of Tennessee. Prof. E. E. Stansbury, 157 pp. One copy for loan from Tennessee's Library. Abstract published in "Microfilm Abstracts." (1957).

*A Calorimetric Investigation of Zirconium, Titanium and Zirconium Base Alloys.** JAMES L. SCOTT, University of Tennessee. Prof. E. E. Stansbury, 122 pp. One copy for loan from School Library. Abstract published in "Microfilm Abstracts." (1957).

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*Mass Transfer Coefficients in the Dialysis of NaOH in the Presence of Ultrasonics.** NARENDA N. BAKHSHI, Virginia Polytechnic Institute. Prof. F. C. Vilbrandt, 257 pp. Copies for loan from V.P.I. Library. Abstract available from Microfilm Service. (1957).

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* Work continuing.

STAINLESS STEELS FOR CORROSION RESISTANCE

Fig. 3. Typical stress-corrosion crack.

To realize optimum performance of stainless steel equipment, attention is now being directed to minimize failures that result from pitting, crevice corrosion, intergranular corrosion, stress-corrosion cracking, and related phenomena where general corrosion is actually slight. In this article the causes and means of avoiding such types of failures are discussed.

L. R. Honnaker * | E. I. du Pont de Nemours & Company, Wilmington, Delaware

Stainless steels are widely used for processing equipment in the chemical industry due to their excellent resistance to the corrosive attack of a variety of chemicals. During the twenty-five or more years' experience with such equipment, considerable data have been compiled (*1*) regarding the general corrosion resistance of stainless steels and suitability of various types for handling specific chemicals. Where such data are not available, they are relatively easy to develop and, as a result, failures due to general corrosion are now relatively infrequent.

Stainless steels may be grouped into three general classifications:

(a) martensitic or hardenable grades containing 11-18% Cr

(b) ferritic or nonhardenable grades containing 15-30% Cr

(c) austenitic grades containing 14-26% Cr and 6-36% Ni.

As a class, the wrought austenitic stainless steels (AISI 300 series) and the corresponding cast grades generally possess better resistance to most corrosive media than those of the other

* Mr. Honnaker is in the Engineering Service Division, Engineering Department.

two classes. They are also more easily fabricated and, accordingly, are used much more widely in the chemical industry for process equipment than the straight-chromium classes. This discussion, therefore, pertains primarily to the austenitic class of stainless steels.

It is generally believed that the good corrosion resistance and so-called passive state of the austenitic stainless steels result from and are dependent upon the presence of a protective oxide film. For this reason, the optimum corrosion resistance is realized under oxidizing conditions which produce and maintain the desired film. It has been shown (*2*) that the composition of the oxide films varies with the composition of the base alloy, and it is believed that the corrosion resistance of the alloy is a function of the composition of the film. If conditions are such that the film is not established or is permeable, stainless steel is little better for practical purposes than unalloyed steel.

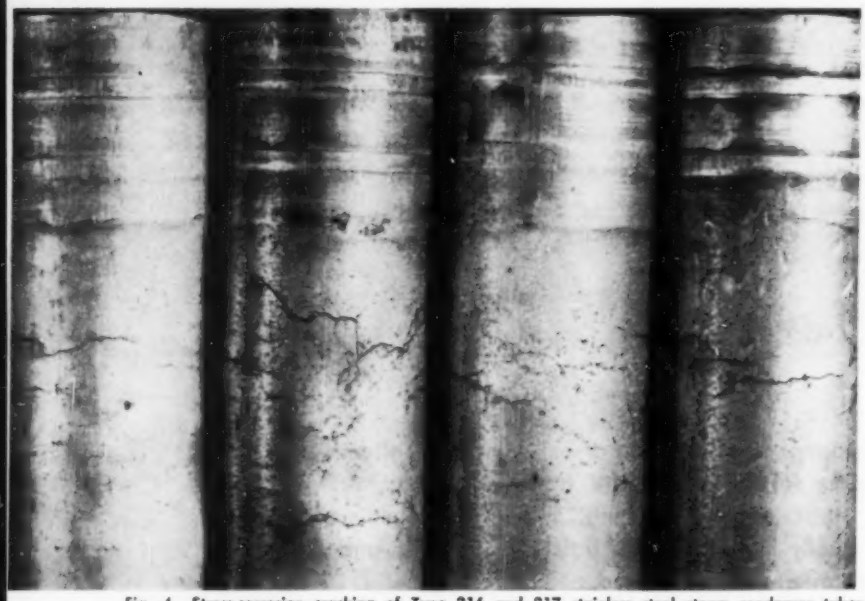


Fig. 4. Stress-corrosion cracking of Type 316 and 317 stainless steel steam condenser tubes exposed externally for 425 days to brackish cooling water averaging 2,840 p.p.m. chlorides.

The added corrosion resistance of molybdenum-bearing stainless Type 316 over Type 304, which contains no molybdenum, is attributed to the enhanced self-passivity or film-forming property due to presence of molybdenum (*3*). Silicon also appears to be beneficial in this respect. Development of fundamental information regarding the nature of the passivity and corrosion resistance is continuing, and there is good reason to believe that stainless alloys of slightly modified compositions, having improved corrosion resistance, will be available soon.

Pitting and Crevice Corrosion

Pitting and crevice corrosion may and frequently do occur in stainless steel equipment even though the general corrosion resistance of the alloy is excellent. Both result from the highly localized breakdown in the passive film followed by electrochemical action. The occurrence may go undetected prior to failure if only casual examination of equipment is made. The presence of chloride salts, even in minute quantities, frequently leads to pitting and crevice corrosion of stainless steel, and precaution should be taken in using stainless steel for handling solutions containing chlorides even though short-time corrosion tests indicate immunity to this type of attack. Collection or accumulation of solids on surfaces is also conducive to pitting and should be avoided where practical.

Crevice corrosion, also known as contact corrosion, frequently occurs at the contact surfaces of flanged joints, coil supports, and incompletely welded attachments, where the corrosive media gets between the surfaces to form essentially a stagnant area or pocket. This results in a change in localized electrolyte composition and entrapment of corrosion products. The contact area may become sufficiently anodic to adjacent areas to cause localized breakdown of passivity and active corrosion. Typical of this type of failure is that occurring under gaskets at flanged joints. The use of nonporous gasket materials will minimize wetting of the contact surfaces and this has been shown to be desirable (*4*).

In general, the molybdenum-bearing Type 316 stainless is more resistant to pitting and crevice corrosion than the Type 304, and its added cost is frequently justified over that of Type 304 for this reason. Design and fabrication details are important, and attention to a few basic fundamentals will avoid conditions that are conducive to the occurrence of such corrosion (*5*). These include free and complete drainage of equipment, avoidance of crevices, and general design for ease of cleaning and inspection. Butt joints with complete weld penetration should be used wherever possible. If lap joints employing fillet welds are necessary, the welds should be continuous on the process side.

Intergranular Corrosion

Intergranular corrosion of stainless steel was a common occurrence fifteen to twenty years ago before the effects of carbide precipitation were understood. It is now generally accepted that in the case of the standard grades of the austenitic stainless steels some of the chromium combines with the carbon to form chromium carbide, which precipitates at the grain boundaries in the temperature range of 1,000-1,500° F. The rate and extent of formation of the chromium carbide are functions of time, temperature, and carbon content. It is generally accepted that chromium carbide *per se* confers no corrosion resistance to steel; and with its formation, there is localized impoverishment of chromium at the grain boundaries causing localized loss of corrosion resistance in some acidic environments. The condition of precipitated chromium carbide at the grain boundaries is frequently referred to as a "sensitized" condition. It generally exists if heat treatment of the material has not been done properly in the mill or foundry or after fabrication by welding.

The most common instance of unsuspected failure due to intergranular corrosion today occurs adjacent to welds in nonheat-treated equipment fabricated from the normal carbon (.06-.08%) or unstabilized grades of the austenitic stainless alloys.

The cause and location of the sensitized areas adjacent to welds which are susceptible to intergranular corrosion may be best explained by referring to plots of time-temperature relationships that occur incidental with welding. The temperature condition and distribution during welding are illustrated in Figure 1. The peak in the family of curves represents the temperature at the point of metal deposition. Due to conduction, the temperature drops off rapidly adjacent to the

line of welding. A typical time-temperature relationship in the metal is illustrated in Figure 2. It has been found that stainless steels sensitize more in a given time in the sensitizing temperature range if the metal is not heated above the upper limit than if the total exposure includes a period above the upper limit.

Sensitization does not cause intergranular corrosion in all corrosive media. Its occurrence is generally limited to attack in acid solutions above room temperature.

It is important to recognize this for economic reasons since final heat treatment of equipment or use of premium grades is not necessary for many of the service conditions for which austenitic stainless steels are commonly used.

Intergranular corrosion can be avoided by heat-treating equipment made from unstabilized grades after fabrication, by employing the columbium (Type 347) or titanium (Type 321) stabilized grades of these alloys, or by the use of the low-carbon grades, such as 304L and 316L. In the case of the stabilized alloys, the carbon preferentially combines with the stabilizing agent and precipitation of chromium carbide is thereby prevented. In the case of the low-carbon grades containing .03% carbon maximum, there simply is not enough carbon available to produce a damaging amount of chromium carbide.

Stress-corrosion Cracking

Another unexpected type of corrosion of austenitic stainless steel that is currently receiving considerable attention is stress-corrosion cracking due to the effect of chloride ion on stressed metal in the presence of oxygen. A significantly large number of failures occur each year as the result of this phenomenon, and persons responsible for the selection and design of stainless equipment should be aware of and give attention to the conditions causing it.

Relatively few of the stress-corrosion cracking failures start on the process side of the equipment. Instead, by far the largest number of failures start on the external or nonprocess side of the equipment which is normally considered to be exposed to innocuous environments.

Stress-corrosion cracking of austenitic stainless is generally associated with chloride-bearing environments and the presence of stress, either residual or applied. The cracking is transgranular and it almost always takes a branching path through the metal. A typical stress-corrosion crack is shown in Figure 3. Its characteristic shape and transgranular path are readily apparent.

"TABLECLOTH ANALOGY" OF HEAT FLOW

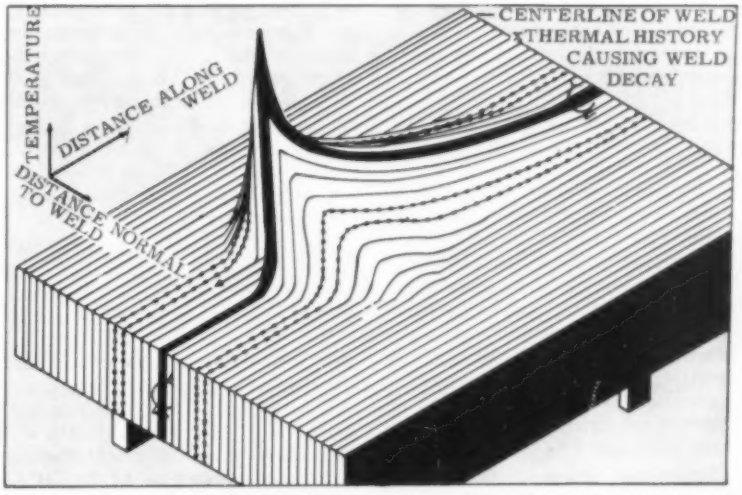
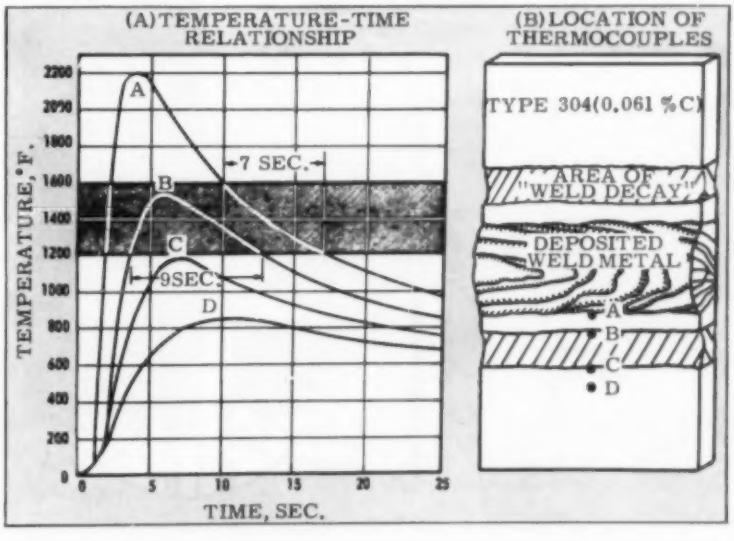


Fig. 1. Visualize a mountain-like block being moved beneath an elastic striped tablecloth. The rise and fall of each stripe represents the rise and fall of temperature in a welded plate.

Stainless-tubed condensers operating in a vertical position with cooling water in the shell show the greatest incidence of stress-corrosion cracking. The source of the chloride is the cooling water, and the location of failure is generally near the top tube sheet. The appearance of a typical failure is shown in Figure 4, in which it will be seen that the cracks are just below the tube sheet, as indicated by positions of the tube sheet hole groove impressions. This location of cracking is attributed to the concentrating of chloride ion under scale deposits that generally occur in this area as the result of inadequate venting of the heat exchanger.

Another common location is in the crevice that exists between the tubes and the tube sheet holes. These two locations are shown in Figure 5. This type of cracking has occurred where the cooling water contained less than 50 p.p.m. chloride. Analyses of scale deposits, however, generally show the

Fig. 2. Heat effect in electric arc welding of 18-8 stainless steel (Type 304).



presence of several per cent of chloride in the area of failure. The service life of austenitic stainless steel tubes in heat exchangers is considered to be a function of stress, concentration of chlorides, and temperature. It is not possible to reduce stress to a level that will guarantee the elimination of cracking. The amount of chlorides in the cooling water is relatively unimportant if conditions are such that concentration of chlorides, i.e., under scale or in crevices, will occur. Temperature is perhaps the most important variable. In reviewing case histories of numerous failures during the last ten years, it has been noted that practically none of the failures occurred where tube metal temperature was less than 80° C. Repeated failures have occurred at higher temperatures, and in the same cooling-water systems the frequency of failure increases with increase in operating temperature. One possible explanation is that concentration of chlorides to a critical amount does not occur below about 80° C.

Experience suggests that where austenitic stainless steel tubed condensers are to be used with chloride-bearing cooling water and metal temperatures in excess of 80° C., consideration should be given to means of avoiding stress-corrosion cracking. Crevices in tube sheet joints should be avoided. Adequate venting should be provided to avoid vapor space in vertical units having cooling water on shell side. If particularly bad conditions are anticipated, consideration should be given to the use of stainless alloys containing more than 25% Ni or the ferritic stainless alloys, such as Type 430 or 446. Bimetallic tubes also provide a practical answer where austenitic stainless is required on the process side.

Second, with respect to the number of stress-corrosion cracking failures occurring in stainless steel, is the cracking that occurs under wet insulation. It has been possible to list approximately forty case histories of failures by this cause in Du Pont plants. The cracking under the wet insulation is attributed to the leaching out of water-soluble chlorides in the insulation and their subsequent concentration on the hot stainless steel surfaces (*6*). Here, again, the quantity of water-soluble chlorides present in the insulation is small, with the average at about .15% by weight, and critical amounts are reached as a result of concentration.

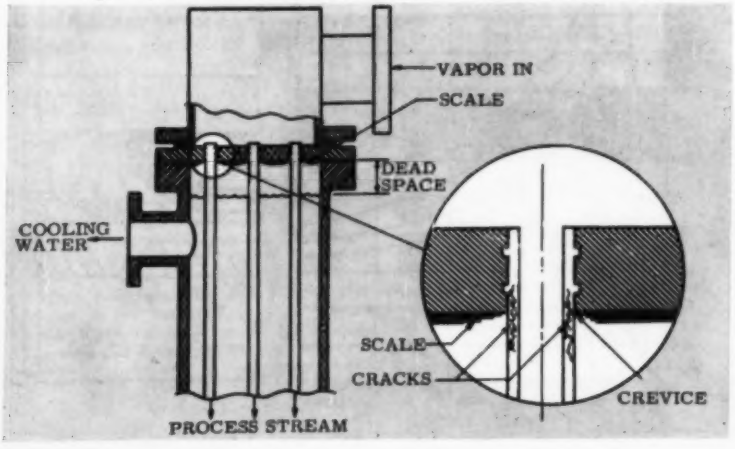
Practically all the equipment failures attributed to wet insulation have been with 85% magnesia. However, results of a current laboratory investigation of the problem show that although 85% magnesia has the greater tendency to produce cracking, it can also occur with other insulating materials such as calcium silicate and glass fiber. Again the critical temperature range appears to be 80-120° C. metal temperature. A number of costly failures have occurred in the last few years, and the major vendors are investigating means of eliminating or making insoluble the chlorides in their insulating materials.

Of practical significance and value here is the fact that cracking is possible only if the insulation gets wet. Two most common sources of water are steam leaks in tracing under the insulation and external water that gets in through breaks or openings in the vapor barrier over the insulation. Continued attention to keep the insulation on stainless equipment dry appears warranted.

Based on plant and laboratory test experience, there appears to be no significant difference between Type 304, 316, 321, 347, or 309 stainless with respect to resistance to stress-corrosion cracking in aqueous media containing chlorides. By way of contrast, none of the 400 series of stainless steel appears to be subject to stress-corrosion cracking in this type media. Some difficult condenser applications have been solved by the use of Type 446 stainless tubes in place of Type 304.

The austenitic stainless steels cannot be protected from cracking in media containing chloride by maintaining a high pH. Cathodic protection may be effective in preventing stress-corrosion cracking, but apparently no practical method has been developed to use this type of prevention. Inhibitors do not appear to afford protection.

Fig. 5. Stress corrosion in the crevice between tubes and tube sheet holes.



Summary

In summary, the general corrosion resistance of stainless steels is only part of the consideration that should be given to the selection and use of stainless steels for chemical process equipment. It is important to consider the possibility of other factors causing unexpected difficulties. Design features that will insure free drainage, ease of cleaning, and elimination of crevices will help to avoid pitting and crevice corrosion. Where acidic conditions are to be handled above ambient temperatures, consideration should be given to the necessity and means of avoiding intergranular corrosion. Finally, the nonprocess or external environments should be considered, particularly with respect to failures by stress-corrosion cracking.

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CORRECTION

In the article "Corrosion—Problem-Solving Methods and Materials" by John Halbig in the November issue of *CEP* (pp. 520-24) there are errors in two of the picture captions. On page 522, the picture to the left shows fifteen to twenty *thousand* specimens exposed to atmosphere at the Middletown, Ohio, corrosion testing facilities of Armco Steel. On page 523, left hand picture, aluminum-on-steel outlasts a zinc coating *3* to 1 and not 30 to 1 as shown.

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If your present packed columns are using either Raschig Rings or Berl Saddles you can increase throughput substantially by re-packing your towers with Intalox Saddle packing.

The data in the accompanying chart show typical pressure drop, loading and flooding points for all three packings in the 1″ size, all operated under a liquid irrigation rate of 2500 lbs./ft.^{2} hr.

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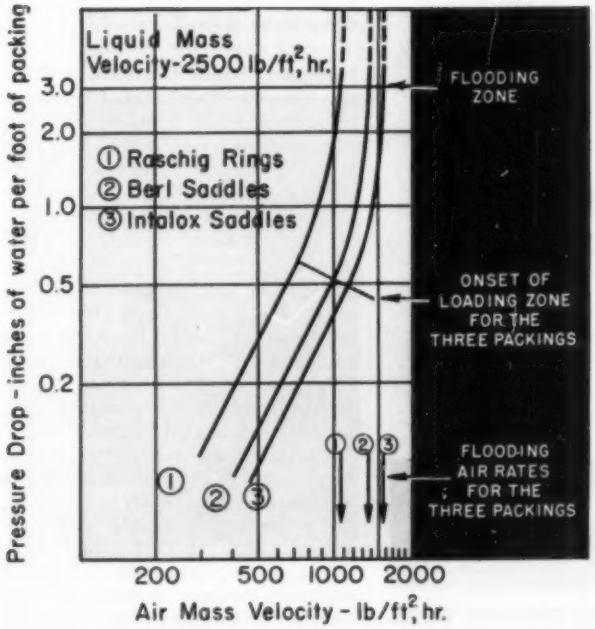

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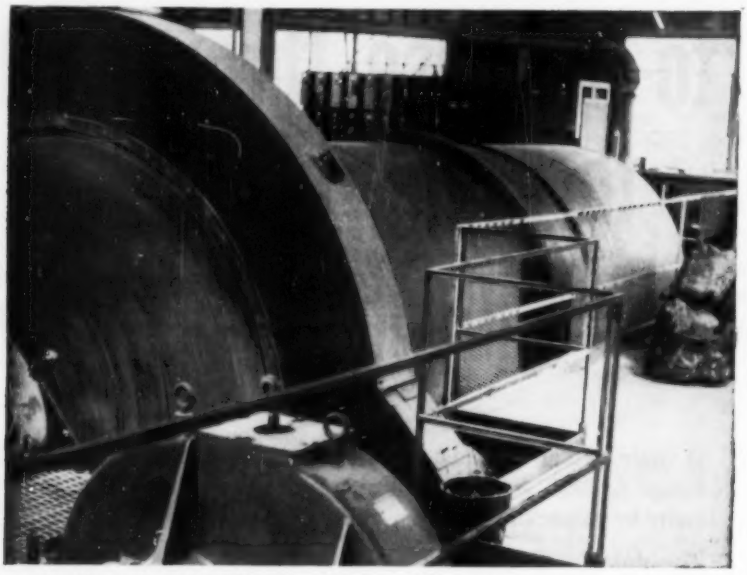

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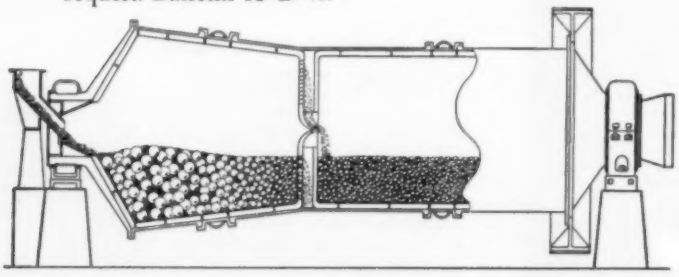

Tricône compartment Tube Mill with grate and lifters.

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INDUSTRIAL NEWS

New $3,000,000 facility is dedicated by Helipot Division of Beckman Instruments. The new 156,000-sq.ft. building in Newport Beach, Calif., will be devoted to the manufacture of Beckman Helipot's principal product, the helical potentiometer, which finds application in electronic instrumentation, supersonic aircraft, radar, and guided missiles.

Ten thousand tons annually of fluosilicic acid, reclaimed from the processing of phosphate chemicals, will be supplied to Kaiser Aluminum & Chemical by International Minerals & Chemical under the terms of a recent five-year contract. Use by Kaiser will be in the first stage of producing synthetic cryolite, vital to the reduction of aluminum. □

Latest entry in the solid propellants field is Amoco Chemicals Corp. whose Seymour, Indiana, plant has begun production of starter cartridges for jet aircraft engines. According to Amoco officials, the entire initial output of the plant will go to the Air Force to fulfill a $3,412,593 contract signed last March. The cartridges were developed by research staffs of Standard Oil (Indiana) and Amoco Chemicals, plant design and construction was by Blaw-Knox. □

Hampton, South Carolina, will be the site of Reichhold Chemicals' fourteenth U. S. plant. First units scheduled for construction are a large methanol terminal and facilities to produce 30,000,000 lb. of formaldehyde annually. Production is expected by July, 1958. □

Manganese ore deposits at Batesville, Arkansas, about 100 miles northeast of Little Rock, will be explored by American Potash & Chemical. Mineral rights to the deposits are held by four Arkansas companies: U. S. Manganese Corp., Arkansas Mining and Exploration Co., Miller-Lipp Corp., and Miller-McGee Manganese Corp., which have worked the properties on a small scale for several years. If exploration results are favorable, plans include formation of a new company to undertake commercial production, with American Potash holding a controlling interest.

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.

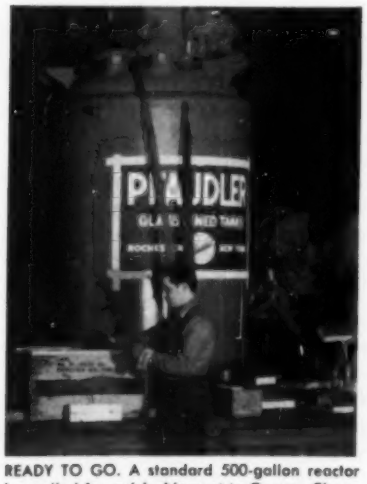
Emergency at Gamma Chemical met by 3-day delivery of 500-gallon reactor

When extra processing capacity was urgently needed recently at Gamma's Great Meadows plant in New Jersey to custom process a new organic chemical, Gamma called Pfaudler and asked how fast a 500-gallon reactor could be shipped.

"How about the day after tomorrow," countered Pfaudler. "Sold!" said Gamma. Waiving the normal ten-day delivery schedule, Pfaudler rushed a standard unit through the shop even before the customer's written order arrived. The emergency was met—a 500-gallon glassed steel reactor was shipped—in just *three days' time!*

Gamma Chemical's plight points up one of the ways you can benefit from Pfaudler's policy of stocking standard glassed steel reactors. Fast delivery is only one of the savings, however. You can also cut initial costs by eliminating special engineering drawings, special parts, and material custom-designed units require.

You get a versatile, corrosion-resistant reactor whenever you specify a standard Pfaudler glassed steel vessel—resistant to all acids (except HF) and alkaline solutions up to pH 12 at 212° F. Each reactor is completely assembled and ready to ship within two weeks from receipt of your order.



READY TO GO. A standard 500-gallon reactor is readied for quick shipment to Gamma Chemical. This vessel was on its way to Gamma's Great Meadows plant even before a written order had arrived!

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The question of when to use a mechanical rotary seal *versus* a stuffing box can resolve itself simply to this:

For a wide range of operating conditions with minimum maintenance —the use of a seal is recommended.

In most normal service of low temperature and pressure, the stuffing box is initially more economical. However, as the service becomes more severe, the rotary seal is superior to the stuffing box on all four of the following points:

1. Chemical conditions. The seal performs better in processes which require freedom from lubricant contamination, from vapor loss, and from contact with metal.

2. Pressure. When pressure ranges from 100 to 300 psi, the seal is normally required. (Special designs are rated up to 1500 psi.)

3. Temperature. Stuffing boxes tend to leak considerably above 350° F. By running coolant through the housing of a rotary seal, you can operate at temperatures tolerable in Pfaudler reactors.

4. Agitator speed. Although this is less critical than other conditions, the seal is usually recommended when agitator speeds exceed 150 rpm.

To give you flexibility of operation, Pfaudler agitators are designed to use *either* seal *or* stuffing box on the *same* shaft. The shaft sleeve (upper right in photo—left) is the interchangeable element. With a Hastelloy sleeve you use a stuffing box. Simply replace it with a "glassed" sleeve and you are ready for a seal. On 3" diameter agitator shafts and larger, you can make the changeover in your plant.

If you would like to study this question more thoroughly, there's considerable factual information in our Bulletin No. 938. Check coupon for copy. *When specified at time of purchase

Now available 1958 BUYER'S GUIDE

Bulletin 947 is a capsule of Pfaudler equipment and services.

Are you aware of the wide range of materials of construction available to you in Pfaudler equipment? Glassed steel, clad and stainless steels, certainly—but do you know the list also includes Hastelloy, nickel, Inconel, titanium, copper and zirconium among others?

Pfaudler reactors, columns and heat exchangers are commonplace, but we also make such equipment as wiped-film evaporators, desludging centrifuges, vacuum dryer-blenders, and piston fillers.

The services, products, and technical aids supplied by Pfaudler—and we add to the list every year—are covered in Bulletin 947.

THE PFAUDLER CO.
Dept. CEP-18, Rochester 3, N.Y.

Please send me information on standard reactors (check size) ☐ 30, ☐ 50, ☐ 100, ☐ 200, ☐ 300, ☐ 500, ☐ 750, ☐ 1000, ☐ 2000; ☐ Rotary seals and stuffing boxes, Bulletin 938; ☐ Buyer's Guide, Bulletin 947.

Name.....

Title.....

Company.....

Address.....

City.....Zone.....State.....

in a teaspoon!

Metallo may hold the answer to your gasket problems in a teaspoon, in a gigantic gasket as big as transportation facilities will allow—or in any one of the many, many standard gaskets available for IMMEDIATE SHIPMENT. In any event, Metallo has the answer, because Metallo has been serving the Chemical Industry for 38 years with gaskets in every size, shape and design conceivable—as well as with standard gaskets fabricated in strict accordance with the customers' specifications and templates.

From vacuum to 30,000 psi, and from -320 f. to +2300 f. Metallo can supply gaskets for your specific purposes.

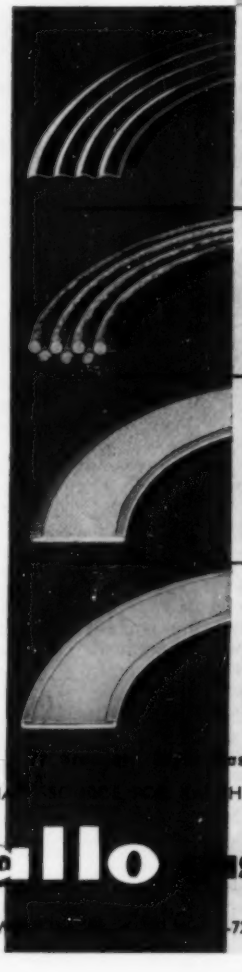
Metallo stock gaskets are made to seal readily and endure the severest attacks of chemical deterioration your process equipment can handle. They are designed to withstand extreme pressure conditions — wide temperature ranges — accommodate expansion and contraction, corrosive and erosive contaminants, absorb shocks, vibrations, misalignments—yet, conform to strictest performance specifications.

IMMEDIATE DELIVERY FROM STOCK

Custom Gasket Orders Given Prompt Attention

Consulting Engineering And Design Service Available At No Cost

WRITE TO DEPT. CEP-1 FOR NEW 2-COLOR 20 PAGE CATALOG.



Style 1
Plain corrugated metal .019 thick with corrugation ¼" pitch in standard or large sizes. 1/16" to ⅜" pitch can be specified.
Recommended for low and medium pressure steam, tar, heavy oils and chemicals.

Style 2
Corrugated .019 metal with best grade hard asbestos cord cemented in corrugation.
Widely used on steam, air, gas and tar lines.

Style 3
Single jacketed with .008 to .019 metal jacket enclosing one face and both edges. Filler can be asbestos millboard, sheet packing rubber, teflon or as specified.
Uses including air, ammonia, chemical, oil and steam lines.

Style 4
Double jacketed; with .008 to .019 metal jacket enclosing both faces and edges. Filler as specified.
For high temperatures, pressures and severe working conditions.

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INDUSTRIAL NEWS

"Largest chemical recovery unit ever" will be put in service at Longview, Washington. Designed and built by Combustion Engineering for Longview Fibre Co., kraft pulp producers, the unit has capacity to burn two million pounds of dry solids/day and generate 300,000 lb. steam/hr. Chemical recovery units are designed to burn "black liquor" from the sulfate process (see *CEP*, p. 497, October, 1957) for heat and material recovery. Smelt accumulated on the furnace bottom is continuously drawn off and reprocessed for reuse in the pulping operation. About 1½ tons of dry solids are obtained for each ton of pulp produced. □

High energy fuel plant of Callery Chemical Co. at Muskogee, Okla. will include an ethylene unit designed by Foster Wheeler. The unit will produce ethylene from ethanol by the dehydration process. The installation (see *CEP*, p. 46, August, 1957) will produce boron fuel for rockets and jet aircraft. □

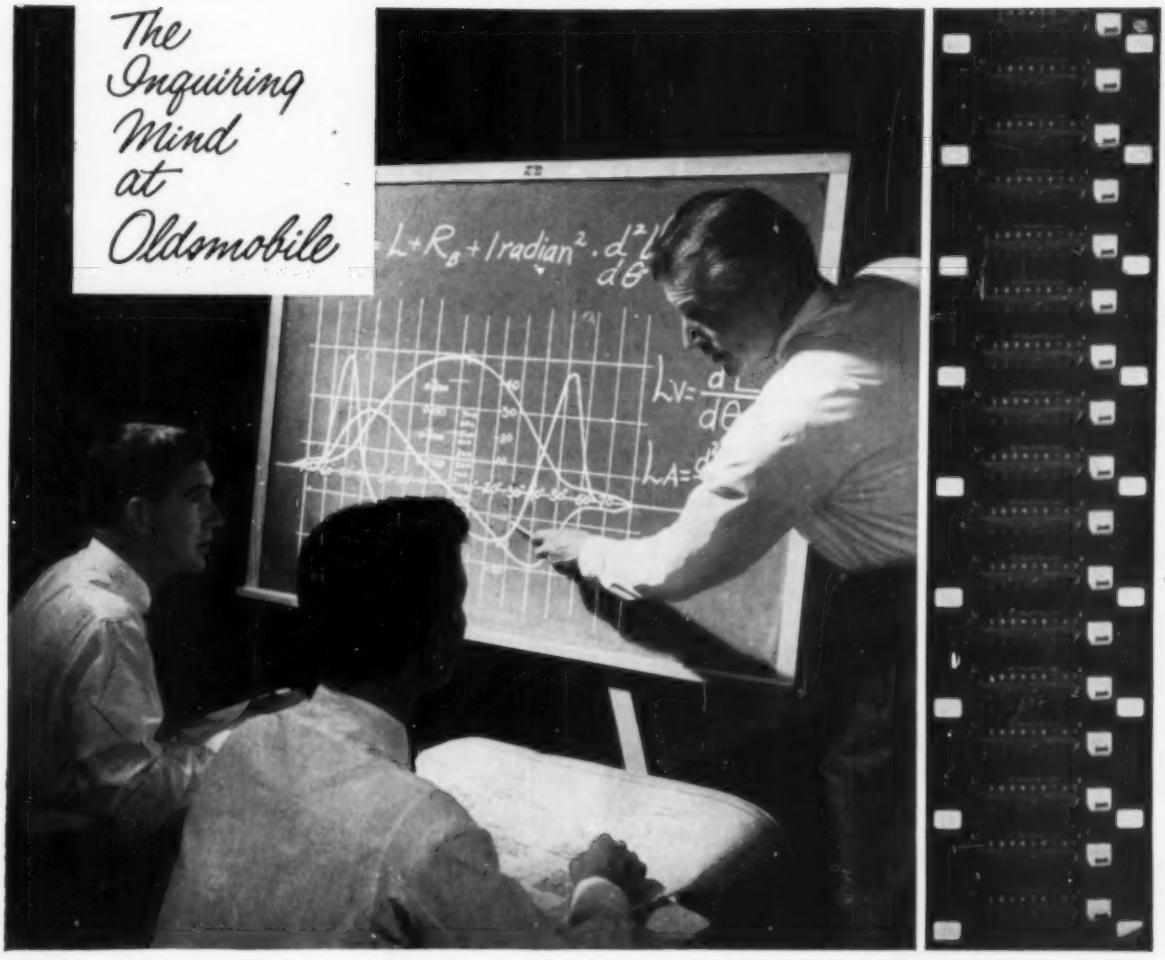
"Stepped-up service to the pharmaceutical industry" is Dow Chemical's goal in establishing a Pharmaceutical Chemicals section. The new section takes the place of Dow's former Fine Chemicals section. □

Low-vacuum version of the high-vacuum molecular still made by Arthur F. Smith Co. will be manufactured and sold by the Pfaudler Co. under the terms of a limited license agreement recently concluded between the two firms. □

A 27,000 b/d Powerformer, slated for operation next summer, is a major unit of the $46,000,000 new construction and modernization program underway at Esso's Baton Rouge, La., refinery. □

Construction will begin immediately on Chemical Construction Corp.'s projected engineering development center in New Brunswick, N. J. Until the new facilities are completed, Chemico will continue to occupy its present pilot plant site in Linden, N. J. □

First shipment of commercial-grade zirconium sponge has been made from Columbia-National Corp.'s new plant near Pensacola, Fla. Commercial-grade zirconium, containing about 2 per cent hafnium, is used as a corrosion-resistant material of construction in the process industries. □



no.1 OF A SERIES

FORMULA FOR A NEW BABY OF OURS

High speed photography helps Oldsmobile engineers translate the theory of camshaft design into practical reality.

Developing the "brains" of an engine—its camshaft—demands engineering skill of a high order, both in theory *and* practice. Advanced techniques of precision measurement guide Oldsmobile engineers in creating a profile design of optimum efficiency.

To determine exactly what happens in a valve train system, movies are taken at speeds up to 15,000 frames per second. The valve train under study is assembled in an engine block and driven by an electric dynamometer at precisely controlled speeds. A vernier scale, silver soldered to the valve spring retainer, is photographed as it moves with the valve's opening and closing.

Essentially, these photographs act as an analog computer. Analysis gives a plot of the actual "lift curve" of the camshaft—the exact linear movement of the valve at each degree of camshaft rotation. It tells at what points the valve opens and closes and also whether the valve lifter is following the cam as it should. This curve, compared to the theoretical lift curve is a definite point for refining to begin—to make sure that design theory will be production practice. With this exact and rapid technique of analysis, as many as 50 experimental camshafts may be tested before a final design is fixed.

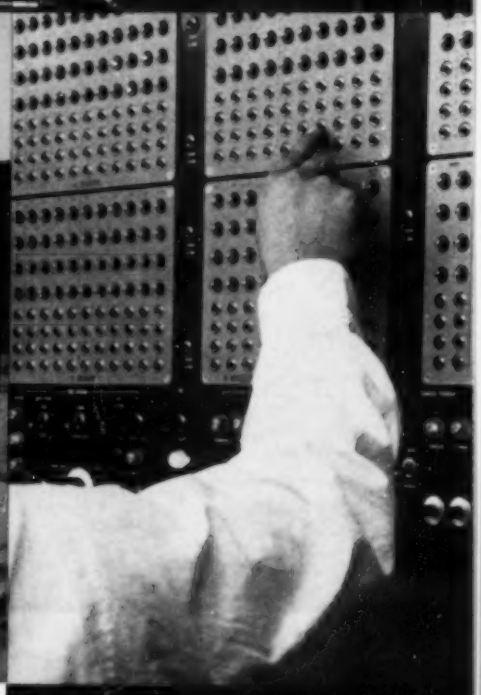
The Inquiring Mind at Oldsmobile is never at rest in its attempt to build the best engineered car in the industry. Test drive the '58 Oldsmobile and you'll find it's the finest product in our 60-year history.

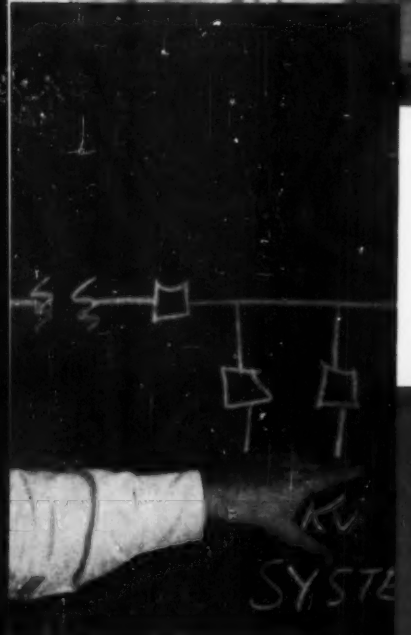
OLDSMOBILE DIVISION, GENERAL MOTORS CORP.

OLDSMOBILE

Pioneer in Progressive Engineering
...Famous for Quality Manufacturing

Fluor's Datatron digital computer frees engineers from routine computation, permitting full use of their creative design talents. Its ability to quickly perform intricate calculations without error shortens engineering lead time . . . assures maximum precision and efficiency in completed plants.





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you can make is in
the creative ability of men.

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CEP Data Service

CHEM SHOW ATTENDANCE OUTSTANDING

The 26th Exposition of Chemical Industries held recently at New York City's Coliseum had a total registered attendance considerably above that of the last similar exposition held two years ago in Philadelphia, according to E. K. Stevens, manager of the International Exposition Company, the firm which manages the show. Stevens, 25 years in exposition management, is already at work laying plans for an even larger show in 1959.

From a tour of the show, it was noted that a larger number of large, full scale items of processing equipment were displayed. One reason for this is the facilities, floor load ratings, and larger space allocations available to exhibitors at the Coliseum. It is understood to be possible to drive large trailer trucks into elevators and directly to the booth sites on the first two main exhibit floors.

The trend toward refinement in process control instruments was noted again at this show, with factory-calibrated plug-in interchangeable components being featured by principal manufacturers. The use of special materials of construction capable of withstanding higher temperatures and other extremes of conditions was seen in several instances.

In the coming months, CEP will present selected items of interest from the show in this (Data Service) section.

NEW VERTICAL DESIGN SIMPLIFIES CENTRIFUGE OPERATION

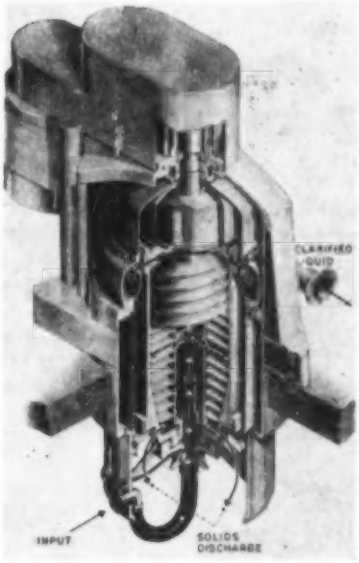
New Sharples P-7000 Super-D-Canter can handle slurry feeds at 200-250 gal./min. at pressures to 150 lb./sq. in. with solids discharge rates to 10 ton/hr.

High speed and high capacity characterize a new vertical design centrifuge, the P-7000 Super-D-Canter, introduced by Sharples at the 1957 Chemical Exposition in New York. According to the manufacturer, sealing problems inherent in the design of a conventional horizontal centrifuge have been largely overcome by a new vertical design which permits pressure-tight operation up to 150 lb./sq.in.

One relatively simple seal at the top seals off the entire gear box and shaft assembly. This seal is located at the maximum distance from the process stream. At the solids discharge end of the vertical machine, the bottom "seal" is actually a motionless flange connection which links the bottom of the Super-D-Canter with the solids collecting tank, conveyor, or other process vessel.

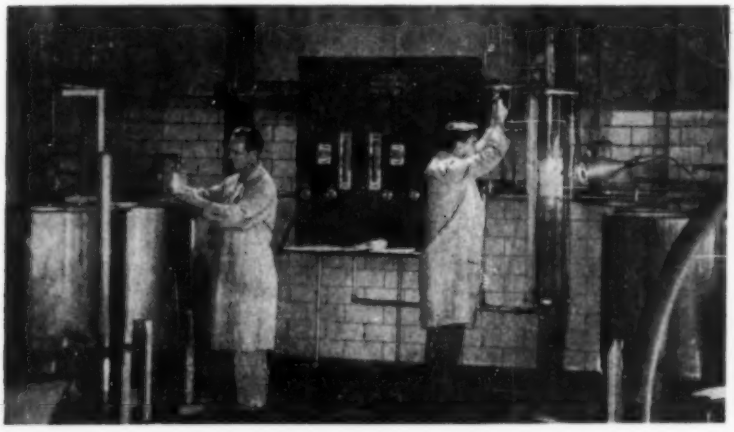
Speed of the unit is 2,000 rev./min., creating a centrifugal force equivalent to 1,640 times the force of gravity. The slurry is introduced into the bowl of the machine by a feed tube connected to a hollow shaft at the base of the bowl. It then flows up this hollow shaft to ports about midway in the bowl, through which it is distributed into the centrifugal force field. Solids are deposited against the wall of the bowl; the liquid forms a concentric inner layer in the bowl.

Inside the rotating bowl is a helical screw conveyor which rotates in the same direction



but at a lower speed than that of the bowl. This conveyor is pitched so that the solids, which are deposited against the wall of the bowl, are conveyed to the lower end of the bowl, where they are discharged through ports. Clarified liquor continuously overflows adjustable weirs at the top of the bowl and is led away through a discharge cover.

Price of the unit is quoted by Sharples at from $30,000 to $60,000, depending on materials of construction which may be either stainless or carbon steels. For further information, circle number 399 on Data Post Card.



NEW LAB TO EXPLORE MIXING OF HAZARDOUS MATERIALS

Multi-stage contactor is feature of specially-designed research laboratory at Mixing Equipment Co., Rochester, N.Y.

Mixing, blending, and separation of solvents and other Class I, Group D materials is the chosen province of a new fluid agitation research laboratory now in operation at Mixco in Rochester. Purpose of the lab is twofold, say company officials: to provide quick and correct answers to specific industrial processing problems involving volatile liquids; to conduct "blue-sky" research for future growth.

Feature of the lab is a continuous mixing

(Continued on page 100)

ADVERTISED IN THIS ISSUE

IFC Equipment for Caps and Trays. Any design—any alloy. Also plastic lining for vessels and tanks. Wyatt's Plastics, Inc.

3R Rotary Sifters. Bull. 503 from B. F. Gump.

4A Fluids Separation Equipment. Mist eliminators, entrainment separators. Otto H. York.

7A Heat Exchangers. Ferrous and nonferrous materials. Texas Metal Fabricating.

8A Plastic Valves and Pumps. Bull. 421—all-plastic gate valve, and catalog 101—seatless plastic pumps. Vanton Pump and Equipment.

9A Capacitance Type Level Position Detector. Bull. F-2408. Fisher Governor Co.

10L Process Equipment Fabrication. Bull. from Downingtown Iron Works.

11A Waste Disposal Systems. Brochure on cutting disposal costs. Dempster Bros.

12L Equipment Fabrication. Pressure vessels, heat transfer equipment. Ellicott Fabricators.

13A Fiberglass-Reinforced Porcelain Valves. Lapp Insulator Co.

15A Continuous Acetylene Process. From naphtha or natural gas. M. W. Kellogg.

16A-17A Diatomite Filter Aids. Johns-Manville.

18A Industrial Jet Apparatus. Bull. 2M from Schutte and Koerting.

23A-24A New Product Information. Sorbitol-alcohol mixtures, polyethylene with carbon black, aluminum silicate textiles. U.S. Industrial Chemicals.

25A Process Machinery and Equipment. Bulletins from Bethlehem Foundry & Machine.

26L Solution of Pipe Expansion Problems. Bull. 31 from Barco Mfg.

27A Process Compressors. Ingersoll-Rand. Consulting service.

28L Steam Jet Ejectors. Graham Mfg.

29A Calcium Hydride Drying Systems. Bull. Metal Hydrides, Inc.

30L Vertical Process Pumps. Layne & Bowler.

31A Tower Packing Booklet. Harshaw Chemical.

32A Worm Gear Speed Reducer Catalog. Cleveland Worm and Gear.

33A Compacting Process. Allis-Chalmers. Bull. 07B8836.

34A Graphite and Carbon Tower Internals. Catalog section S-7340. National Carbon.

35A Compressors. Bull. M-81. Cooper-Bessemer.

36A Stainless Steel Process Equipment. Graver Tank & Mfg.

38A High Capacity Centrifuge. Sharples Corp.

40A Silica Gel. Davison Chemical.

83A Intalox Saddle Tower Packing. Bull. S-29. U.S. Stoneware.

84L Tube Mills. Hardinge Co. Bull. 18-B-40.

85A Process Equipment Buyer's Guide. Pfaudler.

86L Gasket Catalog. Metallo Gasket Co.

87A Automobiles. Oldsmobile Division, General Motors.

88A Plant Design and Construction. Fluor Corp.

93A Process Pumps. Aldrich Pump.

95A Ejector Type Stacks. Prat-Daniel. Bull. A572.

98L Alloy Steel Selection Tables. Duraloy Co.

99R Membrane Type Filters. Croll-Reynolds.

100TL Processed Fullers Earth Adsorbents. Floridin Co. Consulting service.

101A Water Supply Equipment. Layne & Bowler. Bull. 100.

102L Metallic Filter Cloth. Newark Wire Cloth Co. Catalog E.

103A Special Design Condensing Tower. Croll-Reynolds.

104L Spray Nozzle Catalog. Spray Engineering Co.

105A Stainless Steel Valves. Cooper Alloy Corp. Bull.

107A Horizontal Plate Filters. Sparkler Mfg.

108L Teflon Pump Packings. United States Gasket. Bull. AD-155.

109A Lab and Pilot Plant Mixers. Read Standard, division of Capitol Products.

110L Tantalum Corrosion Test Kit. Free to research technicians. Fansteel Metallurgical.

111A Leak-Proof Pumps. Chempump Corp.

112B Electric Bulk Material Distributor. Hayes & Stolz.

113A Packless Control Valve. Bull. 561-A from Leslie.

114L Propane Vaporizer. Richard M. Armstrong.

115R Filter Presses. T. Shriver & Co.

122L Laboratory Glass Stirrers. Ace Glass, Inc. Bull. 5700.

122BR Rotary Mechanical Seal. Bull. C.E.P.-480. Durametallic Corp.

123R Wire Cloth Catalog. Cambridge Wire Cloth Co.

124L Packaged Liquid Coolers. Doyle & Roth.

125A Filters. Eimco Corp. Consulting service.

126L Liquid Chlorine Pumps. Lawrence Pumps, Inc. Bull. 203-7.

127R Twin Strainer. Special back-flushing feature. Elliot Co.

128L Viscometer Application Data Sheet. Brookfield Engineering Labs.

129A Jobs for Scientists and Engineers. Argonne National Laboratory.

130L Spray Nozzle Catalog. Binks Mfg.

130R Pulverizing Equipment. Sturtevant Mill Co.

131L Chemical and Petroleum Engineering Exhibition. London, England, June 18-28, 1958.

131R Heat Transfer Medium Brochure. Thermon Mfg.

132A Steam Tube Dryers. Louisville Drying Machinery Unit, General American Transportation.

136R Thermocouple Extension Wire. Bull. 1200-3. Claud S. Gordon.

136L Centrifugal Pumps. Bull. 107. Frederick Iron and Steel.

137A Vacuum Ejectors. Jet-Vac Corp., Artisan Industries. Folder.

138BL Gear Pumps. Bull. 17-A. Schutte and Koerting.

138BR Precision Bore Tubing Catalog. Wilmad Glass Co.

139A Process Equipment Fabrication. Koven Fabricators. Bull. 550.

140TL Compressed Gas Catalog. Matheson Co.

140BL Pilot Plant Equipment. Edw. Renneburg & Sons.

141A Low Temperature Gas Separation Equipment. Air Products, Inc.

142L Water Purification Equipment. Bull. 146. Barnstead Still & Demineralizer.

142BR Air-Cooled Vapor Condenser. Niagara Blower. Bull. 129R.

143L Packaged Water De-ionizer. Illinois Water Treatment Co.

143R Silica Lab Ware Bulletin. Thermal American Fused Quartz Co.

144L Pulse Code Telemetering Systems. Bull. CP-3012. Vapor Recovery Systems Co.

145TL Flow Meters and Indicators. Bull. M-1 from Schutte and Koerting.

145BL Bin Level Indicators. Bin-Dicator Co.

145R Books on Chemical Engineering. John Wiley & Sons.

146TL "Aero" Heat Exchanger. Niagara Blower Co. Bulletins 120, 124, 135.

146BL Magnetic Separators. Bauer Bros. Co. Bull. M-3-B.

147TL Spray Nozzle Catalog. Spraying Systems Co.

147BL Welded Aluminum Tanks. R. D. Cole Mfg.

147TR Heating and Cooling Coils. Rempe Co.

147BR Machine and Equipment Fabrication. Kutztown Foundry & Machine.

148L Tray Dryers. C. G. Sargent's Sons.

151TR Heating Coil Data. Dean Products. Bulletins 355 and 257.

151BR Technical Data Books. Catalogs from Lefax Publishers.

IBC Controlled Volume Diaphragm Pump. Milton Roy.

OBC Bulletins on Mixing. Mixing Equipment Co.

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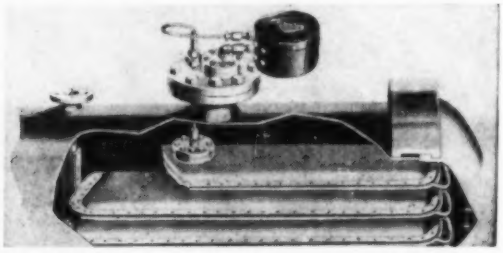
THE BENEFITS OF MEMBERSHIP

in the American Institute of Chemical Engineers are spelled out in the brochure "Know Your Institute," which also outlines the objectives of this nation-wide organization of chemical engineers and includes a membership blank for your convenience. Circle number 403 on Data Post Card.

FILTER CAKE THICKNESS INDICATOR AIDS AUTOMATION OF FILTRATION



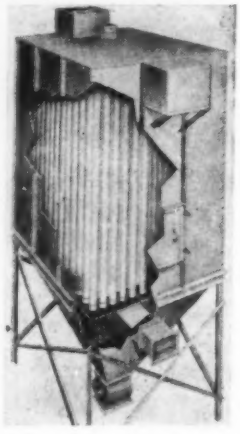
New device said to provide positive control of cake thickness and to eliminate errors by operators.

Fully-automatic operation of leaf pressure filters is now made practical by the new Durco-Enzinger Cake Thickness Detector, developed and made by Duriron Co. Basic process variables in the operation of leaf filters are flow, pressure, clarity, and solids capacity or permissible cake thickness. Flow and pressure have long been controlled by conventional equipment; clarity has become measurable by use of the turbidity meter. Now, automatic control of cake thickness makes it possible to avoid exceeding the capacity of a filter leaf, bridging of the leaves, and subsequent damage to filter elements.

The indicator works by differential pressure at two specific points: the pressure of the filter tank and the pressure slightly inside the filter cake. During the early part of the filtration cycle, pressure at both points is identical. When the cake thickness increases, one pressure sensing element is slightly embedded in the filter cake, and senses a lower pressure than the other sensing point. The differential pressure switch comparing these two pressures closes an electrical circuit to initiate the cleaning cycle.

Commercial types of differential pressure switches are used. These are sensitive to a differential as low as 10 in. of water head. Diaphragm sensing elements filled with silicone oil are used to prevent any fouling or contamination. For further technical details, circle number 401 on Data Post Card.

402 Glass-Bag Filter. The Dracco Corp. has introduced a new glass-bag filter for collecting hot, corrosive industrial dusts and fumes. The use of glass cloth extends cloth filtration into new areas of application. Whereas the limitations of synthetic and natural fabrics used in conventional filter bags have restricted their use to temperatures below 250°, the new unit is able to operate at temperatures to 600° F. and to resist deterioration from all substances except fluorine and hydrofluoric acid. Actual operation of the filter unit is the same as in other conventional filter designs, efficiencies are claimed to approach one hundred per cent. For more information on this development, circle number 402 on Data Post Card.



Numbers followed by letters are for checking your interest in the products, equipment, and services advertised in this issue, the number corresponding to the page on which the ad appears. Letters indicate position on the page: L, left; R, right; T, top; B, bottom. A indicates a full page; IFC, IBC, and OBC are cover advertisements. **Numbers in the 300-series** bring you new engineering data in the chemical engineering field.

Be sure to include your name, address, and position.

Please do not use this card after April, 1958

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January, 1958

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ADVERTISERS PRODUCTS AND ENGINEERING DATA

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32A 33A 34A 35A 36A 38A 40A 83A 84L 85A 86L
87A 88A 93A 95A 98L 99R 100TL 101A 102L 103A 104L
105A 107A 108L 109A 110L 111A 112B 113A 114L 115R 122L
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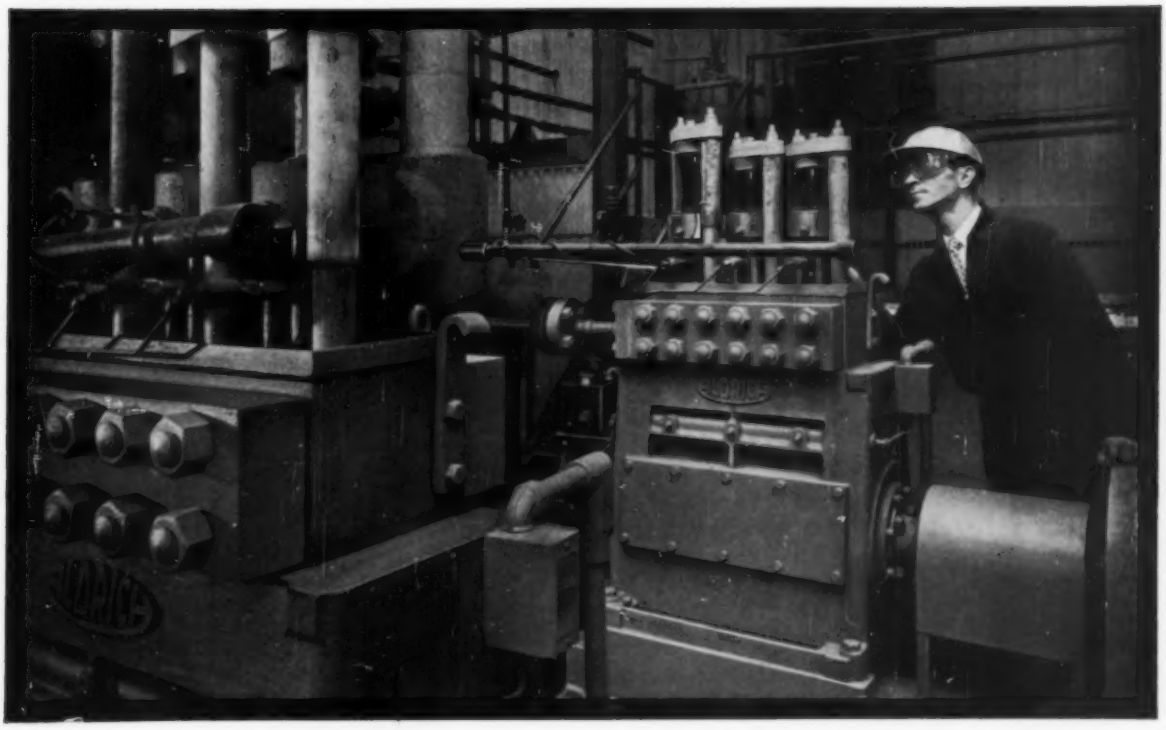
January, 1958

SPENCER CHEMICAL CO. UNRAVELS KNOTTY PROBLEM:

Maintaining a controlled flow of liquid ammonia at high pressures, 24 hours a day.

At the Vicksburg, Miss. plant of Spencer Chemical Company, ammonia production demands two things of pumps: (1) 24-hour, 7-day-week operation and (2) continuous flow of controlled volumes of liquid ammonia at high pressure.



How Spencer licked the problem: When Spencer began outlining construction plans in 1951, company engineers specified two Aldrich Direct Flow, ¾" x 3" stroke Triplex Pumps. These were scheduled to be used for alternate 30-day periods. According to company spokesmen, nearly four years of service have proved these pumps to be efficient and capable of durable service.

Results: Dependability and freedom from trouble in all phases of operation. The Vicksburg Works Maintenance Superintendent tells us: "The Aldrich Pump is an excellent unit. Valve life is excellent and packing life exceptionally good."

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 20 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

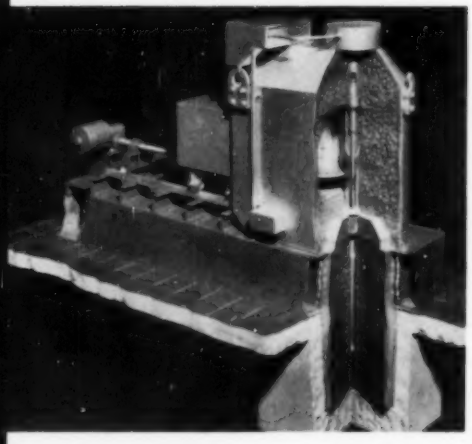
EQUIPMENT

301 All-Transistor Analog-to-Digital Converter. Four-page brochure from Beckman Instruments, Inc., gives specifications, basic circuit diagrams.

DEVELOPMENTS OF THE MONTH *(Cont.)*

404 Self-Contained Irradiator. The Hotrodder, made by Nuclear Systems, division of Budd Co., is a new research tool utilizing radioactive cobalt. The unit is completely self-contained and safe for use in an unshielded room. No auxiliary radiation monitoring or alarm systems, no remote handling or other special equipment is required.

Construction is of heavy stainless steel plate filled with pure void-free lead. Safe capacity is up to 25,000 curies of cobalt 60 and the unit can receive for irradiation samples up to 10 in. in diam. by 10 in. in length.



Operation is simple: the sample to be irradiated is placed on a tray in front of a large electrically-driven, lead-filled block. By pushing a button on the control console, the operator moves the sample into the irradiation chamber which automatically locks itself. The source is then moved into position automatically, the sample exposed and, at the end of a pre-set time cycle—ranging from 1 min. to 120 hrs.—the cycle reverses itself, the sample is removed, and the source safely stowed.

Applications are expected to include the study of processes such as pasteurization and sterilization of foodstuffs, sterilization of prepackaged pharmaceuticals, production of plastics and chemicals with enhanced physical and chemical properties, and the production of new petroleum intermediates.

A technical bulletin describing the unit in detail is offered by the makers. Circle number 404 on Data Post Card.

302 Heavy-Duty Process Pumps. Specially adapted to pulp and paper industry. For capacities to 9,000 gal./min. and heads to 160 ft. Details from Goulds Pumps, Inc.

303 Vibrating Screen Bulletin. Applications, specification data, detailed theory of screening practice. Stephens-Adamson Manufacturing Co.

304 Liquid Level Gauging Systems. Data-Gage, product of Texas Instruments, Inc., combines unlimited-distance, error-safe telemetering, power float accuracy of ±1/16 in. and 100-tank capacity. Bulletin.

305 Crystallizer Bulletin. Describes evaporator, vacuum, cooling, and batch type crystallizers. Operating features and economies itemized in detail. Struthers Wells Corp.

306 Leak-Proof Gate Valves. Dimensions, specifications, drawings of line of gate valves made by Hamer Valves, Inc. Bulletin.

307 Inert Gas Generators. Bulletin from Gas Atmospheres, Inc., gives flow charts, cost analyses, describes typical installations.

308 Process Equipment. Steam jet ejectors, steam vacuum refrigeration, barometric condensers, surface condensers, heat exchangers. Bulletin from Graham Manufacturing Co.

309 Indicating Flow Switch. Differential pressure ranges from 0-20 in. W. G. to 0-50 lb./sq.in. with static pressure ratings to 6,000 lb./sq.in. Barton Instrument Corp. Literature.

310 Cooling Towers. Technical literature from the Marley Co. describes towers to meet every industrial process need.

311 Rotameter Selection Guide. Bulletin from Brooks Rotameter Co. has die-cut disc, eyeletted on inside cover, indicating pressure and temperature limitations, flow capacity ranges of Brooks rotameters.

312 Turbine Type Flowmeter Systems. Pottermeter flow measuring systems have patented, hydraulically-positioned, bearingless rotor, wide linear range of flow rates with high accuracy and repeatability. Bulletin from Potter Aeronautical Corp.

314 Process Chromatograph. For automatic sampling, automatic programming of recorded data, precise regulation of temperatures and carrier flow. Bulletin from Consolidated Electrodynamics.

315 Process Equipment Fabrication. Puget Sound Fabricators, Inc. offer expert metal fabrication services to the chemical, food processing, petroleum, and pulp and paper industries. Bulletin.

316 Molded Teflon Sections and Shapes. 4-page brochure from Sparta Manufacturing Co. describes their patented process for making custom molded parts of Teflon in thin sections and shapes.

317 Thermocouple and Extension Wire. Bulletin from Claud S. Gordon Co. covers their line of Serv-Rite thermocouple and extension wire with bonded staple yarn insulation.

318 Conveyor Bulletin. Specifications, application data on roller gravity, wheel, belt, and live-roll conveyors. Lamson Corp.

319 Process Equipment. Evaporators, vacuum pans, vacuum crystallizers, dryers, drum filters, leaf filters, flakers, heat exchangers. Bulletin from Goslin-Birmingham Manufacturing Co.

320 Linear Accelerator. High-power, high-energy, safe and convenient source of electrons, X-rays, and neutrons for research and production. On sale or lease basis. Bulletin from Applied Radiation Corp.

321 Pressure Vessels, Separators, Mist Extractors. Full details in new 6-page brochure from Ed. W. Smith Machine Works.

322 Titrematic Analyzer. Performs work of a skilled chemist in continuous analysis of a chemical process during manufacture. Technical details from Robertshaw-Fulton Controls Co.

323 Laboratory Apparatus Catalog. Completely new 1,008-page catalog offered by Will Corp. covers about 20,000 laboratory items—products of over 900 manufacturers—fully illustrated with prices.

324 Compressor Bulletin. Brochure from Cooper-Bessemer Corp. describes Type GMXF V-angle, parallel turbo-charged compressors, 330 to 825 bhp.

325 Instrument Accessories and Supplies. 60-page loose-leaf catalog from Foxboro Co. includes specifications, part numbers, and prices for more than 250 Foxboro instrument parts and supplies.

326 Convection Type Dryers. Selection charts, other enginering data, and specifications included in 8-page bulletin from C. M. Kemp Mfg. Co.

327 Separator Catalog. Operating, application, and specification data from Southwestern Engineering Co.

328 Personnel Conductivity Tester. Detects build-up of electrostatic charge on footwear worn by personnel working in hazardous areas. Kahn and Co. Technical literature.

○ **CIRCLE** *your Data Service requests on the handy postcard on page 90 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

329 Zeolite Water Softener Bulletin. Selection data permits choice of equipment to meet individual installation requirements. Allis-Chalmers Manufacturing Co.

330 Heat Exchanger Bulletin. Pfaudler Co. offers bulletin covering technical details and specifications of their complete line of heat exchangers and condensers.

331 Viscometer Instruction Manual. 16-page bulletin from Brookfield Engineering Laboratories describes principles of viscometer operation and calibration.

332 Eye Protection Equipment. Bulletin from Watchemoket Optical Co. describes full line of safety goggles, other eye protection equipment.

333 Vertical Pressure Filters. Selection charts, specifications, other technical details on line of vertical pressure filters. Bulletin from Duriron Co.

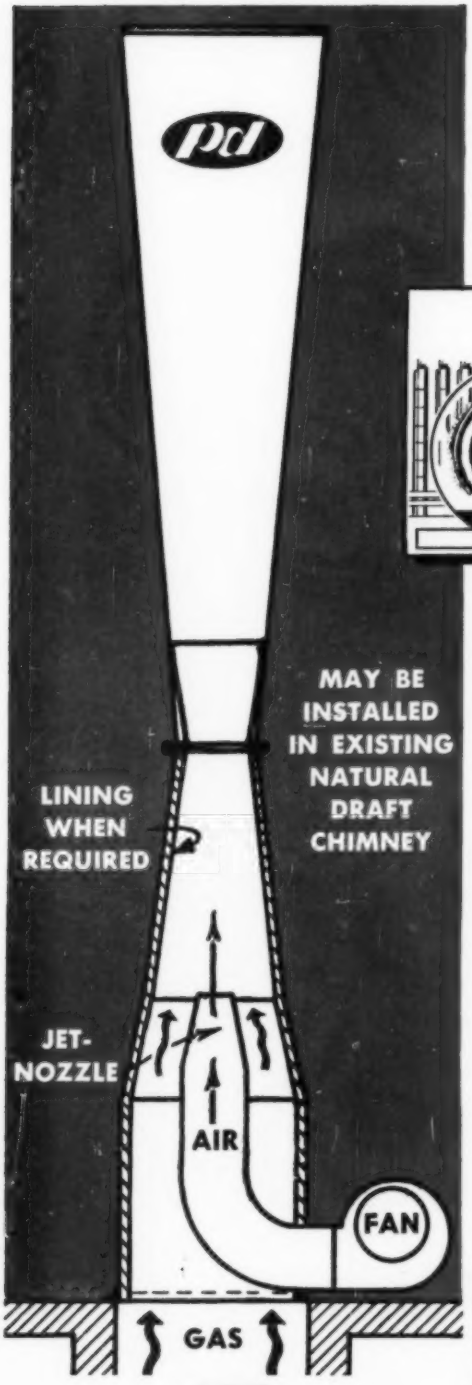
334 Out-of-Circuit Fan Stacks. For handling high-temperature, corrosive, explosive, or product-laden gases. Bulletin from Prat-Daniel Corp.

335 Entrainment Separator Bulletin. Principles of operation, design considerations, installation and application data on Yorkmesh Demisters, product of Otto H. York Co.

(Continued on page 96)

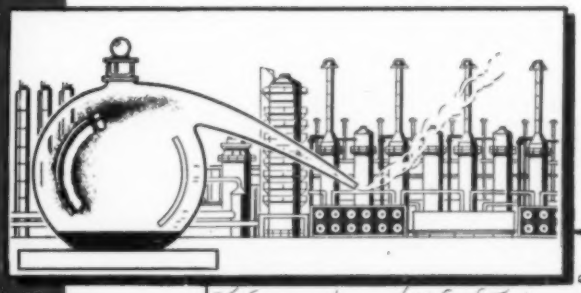
CORROSIVE or 2000° GAS!

PRAT-DANIEL CAN HANDLE IT FOR YOU



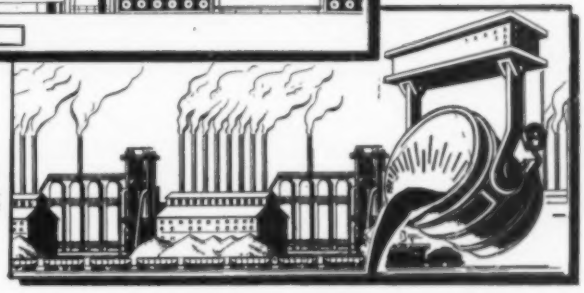
NOTE:
THE FAN HANDLES CLEAN AIR ONLY. WILL LAST INDEFINITELY.

If your problem is to convey or evacuate erosive, corrosive, explosive or high temperature gas, an OUT-OF-CIRCUIT PD FAN AND EJECTOR STACK is your answer. Large or small gas volume. Can be designed small enough for hoods over fuming kettles or for handling huge quantities of gas at steel works. Vertical or horizonal flow — any type of fume or gas at any temperature. Frequently used to boost drafts in existing installations. Get the facts. You may save many dollars in maintenance costs.



FOR CHEMICAL PLANTS

FOR STEEL MILLS



Experience of more than 30 years is behind this effective design. Prat-Daniel Corporation engineers' know-how is backed by many installations made in the chemical, steel and munitions industries. The units can be constructed of carbon steel (brick lined if necessary), stainless, plastic coated or lead lined steel, aluminum, or other materials to suit your needs. Good furnace design usually calls for a PD ejector type stack.

Project Engineers
THE THERMIX CORPORATION
P. O. BOX 1189-S, GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

Designers and Manufacturers
PRAT-DANIEL CORP.
SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

THE THERMIX CORP. P. O. Box 1189-8
Greenwich, Conn.
Gentlemen: Please send me Prat-Daniel Bulletin A572
Name: ..... Title: .....
Company: .....
Street: .....
City: ..... State: .....

EQUIPMENT

(Continued from page 94)

336 Ball and Pebble Mill Handbook. Types of mills and linings, principles of grinding, milling procedures, types of controls discussed in booklet from Paul O. Abbe, Inc.

337 Thermo-Panel Coil Bulletin. 47-page brochure from Dean Thermo-Panel Coil Division, Dean Products, Inc., gives full details of Thermo-Panel Coils. Many curves and charts.

338 Corrosion-Resistant Pipe and Fittings. Complete description of Agile corrosion-proof pipe, fittings, valves, tubing, and ducting. Bulletin from American Agile Corp.

339 Fulljet Spray Nozzles. Operate at spray angle of 120°, offering maximum coverage of pattern area. Bulletin from Spraying Systems Co.

340 Impervite Tube and Shell Bulletin. Latest engineering data on standard and optional designs of Impervite brand impervious graphite tube and shell heat exchangers. Includes dimensions, effective transfer surface, design characteristics. Falls Industries.

341 Nuclear Radiation Instrument Catalog. Brochure from Technical Measurement Corp. gives details of amplifiers, pulse height analyzers, scalers and rate meters, liquid scintillation beta spectrometer, scintillation detectors and crystals.

342 Plastic Flex-Plug Valve. Combines no-pressure drop construction of gate valve with flow-control features of globe valve. Details and engineering data in 4-page booklet from Vanton Pump & Equipment Co.

343 Precision Instrument Bulletin. Condensed bulletin from Schutte and Koerting describes line of precision instruments for measuring, indicating, recording, and controlling rate of all types of fluids.

344 Magnetic Flowmeter for Difficult Liquids. Features include: manual adjustment for any desired flow rate at full scale; unrestricted flow; reading unaffected by velocity profile, density, or viscosity. Technical information from Fischer & Porter.

345 Miniature Instruments. Bulletin from Research Controls covers line of miniature valves and other control equipment specially adapted for pilot plants and research laboratories.

346 Automatic Process Control Bulletins. Series of four bulletins from Swartwout Co. give full details on its "Unitized Autronic" instruments for indicating, recording, and controlling temperature, pressure, level, flow, pH. Specifications, performance data.

347 Comparative Heat Exchanger Costs. Booklet provides rapid analysis of comparable costs between plain condenser tubes and Trufin Type S/T, made by Wolverine Tube, Division of Calumet & Hecla.

348 Multi-Purpose Processing Unit. Cornell Machine Co. offers bulletin on the Versator, compact unit for processing liquids, pastes, greases, other flowable materials. Mixes and blends, emulsifies, disperses, dehydrates, foams. 1 to 20 gal./min.

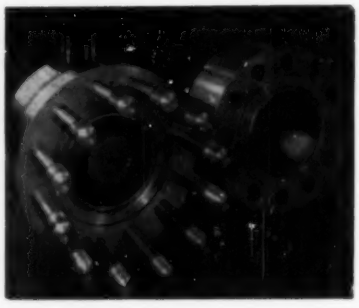
349 Chemical Feeder Catalog. Manzel, division of Houdaille Industries, will send 36-page booklet on metering pumps. Includes volumetric conversion tables, listing of components and accessories.

350 Quick Coupling Bulletin. Describes line of Ever-Tite couplings, available in aluminum, stainless steel and malleable iron, other metals on specification. Ever-Tite Coupling Co.

351 Processing Equipment Bulletin. Describes Sprout-Waldron equipment for size reduction, mixing, bulk materials handling, size classification, pelleting. 20 pages.

352 Vibratory Feeder Catalog. Syntron Co. offers catalog data and specifications on its new model F-115 vibratory feeder, designed for high-capacity feeding of bulk materials in weighing, blending, mixing, and packaging operations.

DEVELOPMENTS OF THE MONTH *(Cont.)*



405 High-Pressure Entrainment Separator. Units designed to withstand pressures up to 15,000 lb./sq.in. for air, steam, and process vapor and gas lines are now offered by V. D. Anderson Co. Pressure parts in the new HI-eF purifiers are of special alloy steel with special gaskets and pipeline connections. The unit employs no moving parts, filters, or mesh screens of any type, but operates by a new patented two-stage principle of separation that employs carefully-controlled centrifugal force to guide the entrainment-laden vapor through a series of vanes and baffles. Large droplets are removed in the first stage by impingement against a baffle. Fine mist is removed in the second stage by centrifugal scrubbing action through a specially-designed separation element. Further technical information may be had by circling number 405 on the Data Post Card.

353 Heavy Duty Dispersion Mixer. Has been applied successfully to processing of solid propellant fuels. Available in range of laboratory and production sizes. Details from J. H. Day Co., division of Cleveland Automatic Machine Co.

354 Air-Pollution Control Systems. Technical literature from Oxy-Catalyst, Inc. features four problem-solution case histories of Oxycat catalytic installations in organic finishing and drying, chemical processing, oil refining, food processing.

355 Small Controlled Volume Pumps. New model MiniPump, product of Milton Roy Co., for flow rates to 7,880 milliliters per hour, pressures to 1,000 lb./sq. in. Prices and specifications from maker.

356 Filtration Equipment Catalog. New catalog describes Fulflo and CFC filtration equipment for micronic clarification of all types of fluids. Commercial Filters Corp.

357 Titanium Fittings. Ladish Co. offers pamphlet "Titanium Moves Into Process Equipment," dealing with properties and corrosion resistance of titanium.

358 All-Glass Y-Type Valve. All working parts exposed to fluid are of glass or Teflon. Can handle acidic fluids of all concentrations or compositions at temperatures up to 250° F. Information from Corning Glass Works.

359 Dry Chemical Feeder Bulletin. New unit, introduced by Wallace & Tiernan, has self-cleaning feeding mechanism, will feed up to 2.85 cu.ft./hr. Hopper capacity is 3¼ cu.ft.

360 Meters For Liquid Propane, Butane. New 8-page bulletin from Rockwell Manufacturing Co. describes liquid meters for liquid propane, liquid butane, and liquid propane-butane mixtures.

361 Valve Operators. Type SA LimiTorque Valve Operators, made by Philadelphia Gear Works, feature pre-set compensating springs, assuring a tight valve seat. Can be mounted on any size valve in nearly any position. Bulletin.

362 Components of Liquid Metal Systems. Six new bulletins from General Electric Co., Atomic Power Equipment Dept., describe components for use in pumping and purification of liquid sodium and sodium potassium systems in the nuclear, metallurgical, petroleum, and chemical fields.

363 All-Purpose Electrical Controls. Assembly Products, Inc. offer bulletin on Versatrols, all-purpose electrical controls, claimed suitable for use with virtually any detectable variable. Bulletin explains application of most common circuits, including new Load Sentry overload control.

364 Low-frequency Transducer. National Carbon Co., jointly with Texas Research Associates, announces commercial development of the solion, which may replace the transistor at frequencies below 100 cycles/sec. The solion is based on use of ions in solution. Details from National Carbon Co., Electronics Products Dept.

365 Rotary Valve Bulletin. Dimensions, specifications, capacities, applications of Style "A" rotary valves made by the Day Co.

366 High-Speed Slurry Pump. New, medium-range, high-speed slurry pump for handling suspensions of sand, coal, crystals, silt, sludge, lime, or chemical process slurries. Bulletin from Morris Machine Works.

367 Data on Industrial Periscopes. Bulletin from Kollmorgan Optical Corp. gives technical details of industrial periscopes for remote observation of processes in presence of harmful radiation, high temperatures, pressure, water, or toxic gases.

368 Cast Steel Gate Valves. New, 4-page bulletin describes 150 and 300 lb. cast steel gate valves made by Walworth Co. Dimensions, weight charts, line drawings for each type.

370 Viscometer Bulletin. Describes Norcross instruments specially adapted for polymerization and similar processes. Recorders available with alarms and/or controls for all types of batch and continuous processes. Norcross Corp.

(Continued on page 98)

Worthite filter feed pump at Farmers Chemical Company, Joplin, Mo. Worthite is a Worthington Corporation trademark for their corrosion-resisting, nickel-containing alloy. Composition: 24% Ni, 20% Cr, 3.25% Si, 3% Mo, and 1.75% Cu.

Made of nickel-containing stainless steel...

Long-lasting parts in this pump take phosphate-gypsum slurry in easy stride

In a plant producing high analysis phosphate fertilizer, this Worthington Corporation filter feed pump does a bang-up job with hard-to-handle gypsum slurry.

And that's understandable—because impeller and impeller casing, shaft and suction head are all made of Worthite, a cast Ni-Cr-Mo austenitic stainless steel containing 24% nickel.

The pump pictured here, for example, handles slurry with a dilution of 1.4 parts of solution to 1 part of solids. Solution is 32% P_2O_5 with dissolved calcium sulphate, 1% free H_2SO_4, up to 3% hydrofluosilicic acid and fluosilicates and traces of hydrofluoric. Solids are primarily 100-400 mesh gypsum with about 5% 60-100 mesh unattached phosphate particles, mostly silica. Temperature: 158°F. Specific gravity: 1.66. Flow: 480 gpm.

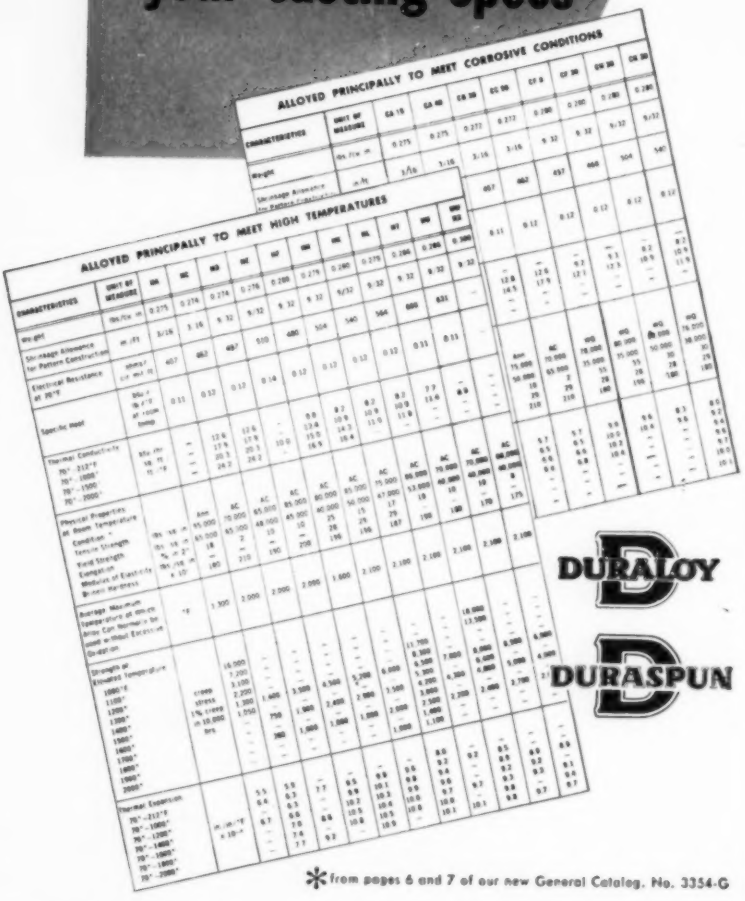
In this service, impeller, shaft and suction head have an average life of 26 months, the impeller casing 31 months. Under slightly less severe conditions in the same plant, other Worthite pumps have had no replacement of parts in three years of continuous use.

Perhaps a cast or wrought stainless steel containing nickel can help *you* combat corrosion and abrasion, or meet some other specific need. For information to guide you in selecting the right alloy, get in touch with Inco's Development and Research Division. They're always glad to be of service to metal users.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL
NICKEL ALLOYS PERFORM BETTER LONGER

TABLES to help you select the proper alloy for your casting specs



DURALOY

DURASPUN

*from pages 6 and 7 of our new General Catalog. No. 3354-G

— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

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CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

EQUIPMENT

(Continued from page 96)

371 Ductile Iron Diaphragm Valves. Exceptional strength and resistance to fracture and thermal shock. Complete information from Hills-McCanna Co.

372 High-Pressure Solenoid Valve. Rated to 6,000 lb./sq.ft., new two-way stainless steel solenoid valve is available from Aktomatic Valve Co. Bulletin with detailed technical information.

373 Corrosion-Resistant Valves and Seats. Line Scale Co. offers bulletin on corrosion-resistant valves and seats said to fit all standard makes of reciprocating pumps. Bulletin includes complete materials specifications and ordering data.

374 All-Plastic Self-Priming Filter Pumps. Sethco Mfg. Co. offers technical literature describing a new design and several additions to its line of all plastic filter pumps for corrosive solutions.

375 Bellows-Type Flow Meter. Accuracy to within one-half of one percent is claimed for new bellows-type flow meter developed by Minneapolis-Honeywell Regulator Co. Technical literature.

376 Heavy Duty Steam Heating Coils. Catalog from Westinghouse, Sturtevant Division, gives selection data, suggested piping arrangements for extra-heavy wrought iron heating coils.

377 Control Valve Catalog. Flo-Pilot valves are available in ¼ in. pipe size for two or three-way air operation to 150 lb./sq.in. Five basic models—ball cam, palm button, hand lever, locking hand lever, and mechanical link clevis. Hanna Engineering Works.

378 Particle Size Analyzer. General purpose instrument for measurement of size distribution of small particles. Bulletin from Mine Safety Appliances Co.

379 Liquid Level Gauges and Valves. Complete condensed catalog from Jerguson Gage & Valve Co. gives dimensional drawings, construction features, pressure-temperature features, pressure-temperature graphs and ratings, materials, tables of sizes, specifications, standard and optional features.

380 Analyzer for Gases in Metals. New 16-page brochure from Fisher Scientific Co. describes Serfass Gas Analyzer which can measure hydrogen, oxygen, and nitrogen in steel, titanium, nickel, manganese, niobium, zirconium, vanadium, uranium, plutonium.

DEVELOPMENTS OF THE MONTH *(Cont.)*

369 Vapor Fractometer Bulletin. A brochure describing two new gas chromatography instruments, the Model 154-C single-stage vapor fractometer, and the Model 188 triple-stage vapor fractometer, is offered by Perkin Elmer Corp. The Model 154-C offers all the specialized features of the P-E 154 series, plus an ex-

SERVICES

381 Processing Equipment Fabrication. Custom fabrication of agitators and blenders, autoclaves, electro-galvanizing and plating equipment, packaged production systems, vacuum chambers, vacuum & pressure impregnators. Fey-Steel Co.

382 Nuclear Safety Service. A new scientific and engineering service providing independent reactor and radiation hazard evaluation. Holmes & Narver, Inc. Bulletin.

MATERIALS

383 Lignan Chemicals. Bulletin from Crown Zellerbach Corp., Chemical Products Division, describes industrial applications of the "Orzans" (surface-active chemicals derived from wood pulping).

384 High Temperature Insulation Comparison Chart. Gives comparative data on operating conditions, physical limitations, economic factors, thermal transmission, selection. Brochure from H. I. Thompson Fiber Glass Co. describes properties of Refrasil, 2,000 to 3,000° F. high temperature insulation.

385 Basic Chemicals Catalog. Olin Mathieson Chemical Corp. offers 16-page booklet describing characteristics, grades, and containers for 24 basic chemicals used by industry.

386 Data on Detergents. Fourteen liquid and solid nonionic detergents listed in chart form according to physical characteristics, hydrophilic-lipophilic values, solubility in various solvents, foaming, cloud point. Brochure from Atlas Powder Co.

387 Refractories for Petroleum Processing. Technical data on eight types of castable refractories, for service to 3,000° F., fireclay, super-duty and high-alumina refractory brick, insulating refractories, bonding mortars and clays, tower packings, acid-proof brick and tile. Bulletin from Harbison-Walker Refractories Co.

388 Corrosion Data. Materials Engineering reference files from Blaw-Knox Co. discuss caustic embrittlement, galvanic corrosion.

389 Alkyl Boric Acids. Three new alkyl boric acids (alkyl, dihydroxy, boranes) are available in research quantities from Callery Chemical Co. Information on properties and chemical nature of these materials will be sent by the manufacturer.

390 New Polyethylene Resin. Epolene "C" can be handled as a melt, with or without modification. Viscosity at 300° F. is 8,000

(Continued on page 100)

panded line of standard columns, precision electronic temperature regulation, reverse flushing features, and automatic recorder range control.

According to the manufacturer, the Model 188 triple-stage vapor fractometer makes possible for the first time the single run analysis of a sample containing a large number of components which boil over a wide range. The instrument is designed to make three rough cuts of a total sample without need for pre-separation, and to produce three simultaneous analyses under optimum chromatographic conditions.

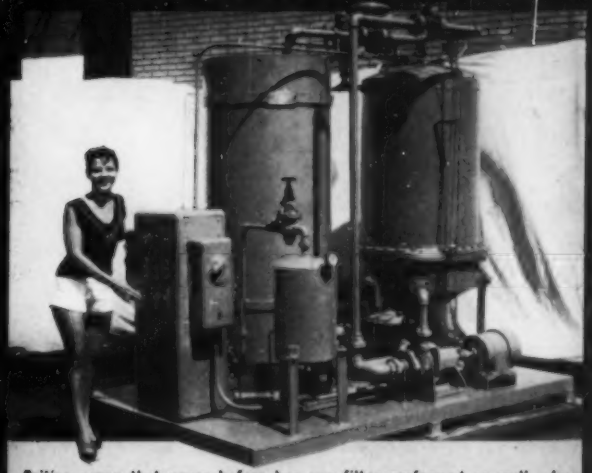
The 24-page brochure describes flow schematics, sampling features, applications, and specifications of the new units. To obtain a copy, circle number 369 on Data Post Card.

CROLL-REYNOLDS

presents

new ClaRite FILTERS

...in an OUTSTANDING 5-STAR performance



Critics agree that never before has any filter performed so well — by eliminating particles down to 1/10 of a micron with unequaled flow rates, ClaRite filters combine the highest throughput with brilliant clarity.

AND CROLL-REYNOLDS' VERSATILE ClaRite FILTERS RATE 5-STARS BECAUSE THEY

SAVE MONEY — no need for bags, pads, cloths, cartridges, etc. . . . longer runs are achieved . . . overall cost of production reduced unbelievably.

SAVE TIME — unique wedge opening tubular filter membranes give 3-5 times greater flow with less surface area than other types of filters . . . downtime for cleaning is reduced to a few minutes . . . absolute minimum loss of filtration time assured.

SAVE LABOR — high velocity backwash eliminates manual disassembly and cleaning once and for all! . . . a few moments of labor time per filter cycle certainly will be a saving for you when compared with your present labor cost.

SAVE TROUBLE — permanent membranes and top quality accessories prevent breakdowns, costly delays and loss of expensive product through leakage, clogging or break through of filter media . . . an unequaled simplicity of maintenance achieved in ClaRite design.

IMPROVE YOUR PROCESS and PRODUCT increase flow rate and process efficiency . . . impressively improve filtration clarity, whether your process is small or large, batch or continuous, mild or corrosive.

Standard ClaRite filters, offered according to specific requirements in three types of filter membranes, are available with from 5 to 185 sq. ft. of filtration area, constructed of carbon steel, stainless steel, or lined carbon steel. Special designs available for larger or smaller units or for units constructed of other materials. For additional information, write today.

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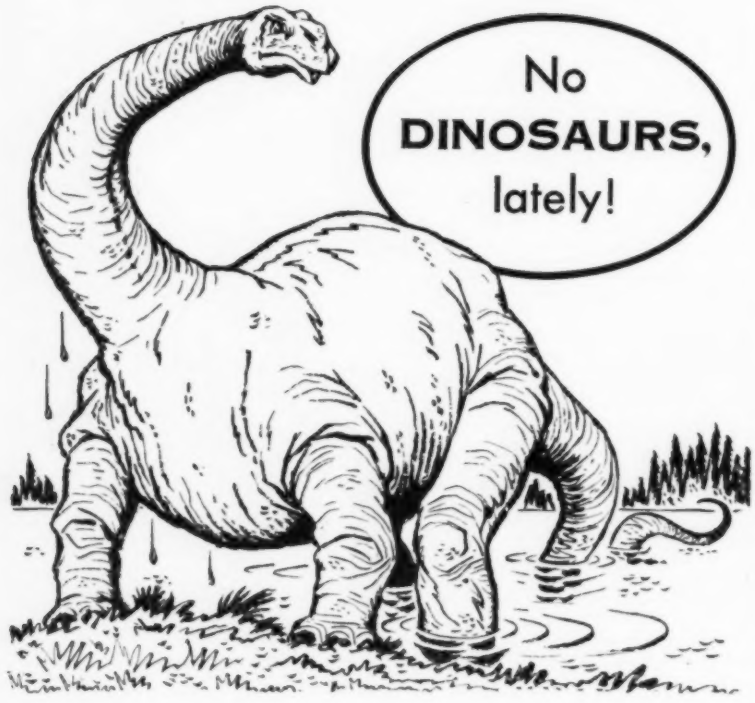
Croll-Reynolds

ENGINEERING CO., INC.



The extensive magnesium silicate deposits laid down about the time dinosaurs roamed Florida's marshy peninsula became the source of today's most wisely used adsorbent.

Because it contains numerous small fibrous tentacles, Florida Fullers Earth, in its commercial form known as Florex, is particularly valuable in the adsorptive refining, decolorization, clarification and neutralization of mineral, vegetable, and animal oils, fats and waxes. Florex is unequalled in high quality or low cost for processes involving the use of highly active clay for sweetening light distillates, dehydration, desulfurization, and polymerization.

Standard meshes from 2/4 to 200/up and our experienced adsorption specialists are available to help you solve complex laboratory or production problems.

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MATERIALS

(Continued from page 99)

cps. Addition of 25% paraffin reduces viscosity to 1,300 cps. at this temperature. Details from Eastman Chemical Products, Inc.

391 Adhesives Booklet. Johns-Manville Dutch Branch Division offers 10-page booklet describing new facilities for production of solvent-based, solvent-based pressure-sensitive, and solvent-activated adhesives.

392 Copper Sulfate Bulletin. Production methods, specifications of various grades, application data contained in brochure from Republic Chemical Corp.

393 Data on Fatty Acids. New booklet "Specifications and Characteristics of Fatty Acids" offered by Emery Industries, Inc. Also list of current technical literature offered by Emery.

394 Silicone Rubber Sheets. Data sheet from Connecticut Hard Rubber Co. gives properties of 50, 60, and 70 durometer silicone rubber sheets and fabric-reinforced silicone rubber sheets for minus 85 to plus 500° F. applications. Samples also available.

395 Physical Properties of Organic Chemicals. New 28-page booklet from Union Carbide Chemicals Co. gives physical properties data on more than 350 organic chemicals.

396 Data on Stability of Peroxides. Tabular-form data on stability of various peroxides in both dry and paste forms. Includes rates of decomposition at different temperatures and changes in appearance. McKesson & Robbins, Inc., Chemical Dept.

397 Technical Manual on Butadiene. Texas-U.S. Chemical Co. offers 52-page manual containing specifications, physical and chemical properties, 150 chemical reactions, end uses, reactants and reaction products. Includes bibliography with more than 300 references.

398 Data Sheet on Gadolinium. Lists high-temperature properties of gadolinium, also properties of gadolinium nitrate solutions. Research Chemicals, Inc.

HAZARDOUS MATERIALS

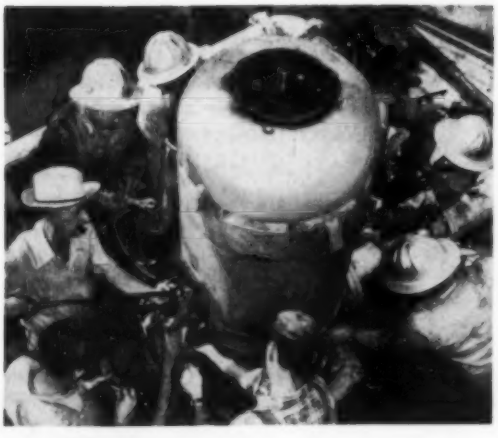
(Continued from page 89)

facility with a prototype of a new Mixco multi-stage contactor. The 48 in. high and 6-in. diam. contactor is convertible to various numbers of stages, from 8 to 32. Impeller speeds and diameters, stage opening sizes, and disengaging zones at top and bottom provide variables for testing. It is now possible, says Mixco, to establish a "flow pattern" in each stage of the contactor similar to that obtained in individual tanks of a multi-tank system. This permits the use of already-established data to determine accurately the feasibility of a given multi-stage mixing operation.

"Liquid-liquid extraction and liquid-solid extraction can now be studied in either batch or continuous flow experiments," says J. Y. Oldshue, Mixco's research director. "Among the process requirements that we are now equipped to study are rate of extraction, interfacial area produced in a two-phase system, rate of settling of a two-phase dispersion, and rate of reaction."

For more information on this new service facility, circle number 400 on Data Post Card.

Where service begins-LAYNE



Completely equipped work crews handle water well and pump servicing — backed by over 75 years of field experience.

A telephone call brings action—for the service facilities, know-how and experienced work crews of your nearby Layne Associate Company.

Layne service is based upon undivided responsibility throughout every phase of every water development job, from initial surveys and construction, to operation and maintenance.

For service before, during and after well construction, look to Layne and your nearby Layne Associate Company, a member of the community it serves.

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Water Wells • Vertical Turbine Pumps • Water Treatment

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Memphis 8, Tennessee

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Please send me Bulletin No. 100

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*Title*_____

*Organization*_____

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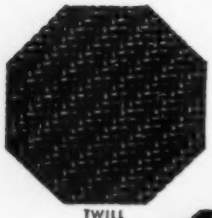
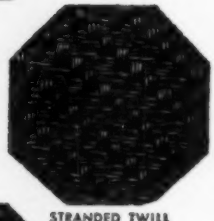
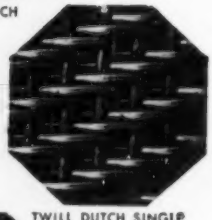
Newark Metallic Filter Cloth...

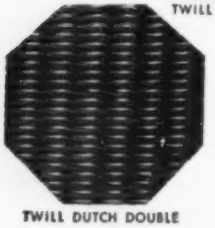

TWILL


STRANDED TWILL

PLAIN DUTCH

Enlarged approximately 3X


TWILL DUTCH SINGLE


TWILL DUTCH DOUBLE

Newark Metallic Filter Cloth does stop solids — the wedge-shaped openings allow only the filtrate to pass through. And, Newark Cloth is reversible, both sides being identical. Newark Metallic Filter Cloth is woven firmly and uniformly without loose wires, guaranteeing good filtration all over.

Newark Metallic Filter Cloth is available in a variety of weaves in *all* malleable metals, and is adaptable to practically all types of filters. When writing, please give us details on your process.

Send for our NEW Catalog E.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

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GIBBS AND WESTINGHOUSE HONORED AT HALL OF FAME

Unveiled at the Hall of Fame for Great Americans at New York University December 1 were bronze busts of Josiah Willard Gibbs and George Westinghouse. Principal speakers were former President Herbert Hoover and Detlev W. Bronk, president of the National Academy of Sciences.

Gibbs, a mathematical physicist and professor at Yale, formulated the theory of thermodynamics, the basis for much of modern physical chemistry and chemical engineering. He was selected for the posthumous honor in 1950. The following words from Professor Gibbs were inscribed on his plaque:

One of the principal objects of theoretical research is to find the point of view from which the subject appears in its greatest simplicity.

SELECT 1957 A.I.Ch.E. STUDENT CONTEST WINNERS

Requests for 2,320 copies of A.I.Ch.E.'s 1957 Student Contest Problem were received from 79 different colleges. Winners of the first three prizes were ultimately selected out of the 56 students from 35 colleges who submitted completed solutions to the A.I.Ch.E. judging committee.

Colleges whose students were this year singled out for honors were: *Worcester Polytechnic Institute*, whose George H. Long, Jr. took first prize (student chapter counselor—W. L. Kranich); *University of Illinois*, alma mater of second prize winner Sam C. Vickers (student chapter counselor—M. S. Peters); and *Notre Dame*, represented by Robert M. Weiner, who won third prize (student chapter counselor—R. E. Rich).

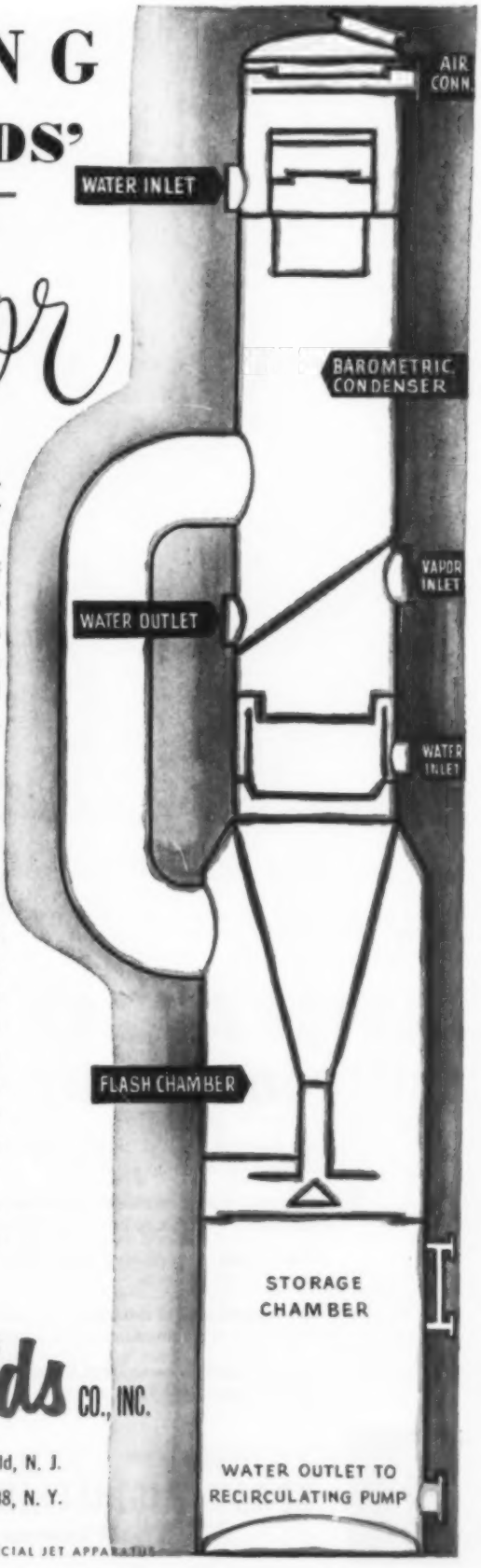
A giant $12,000,000 Science Center will be erected at the University of Georgia. Construction will start immediately on two of the six projected buildings. The Center will include facilities for nuclear research as well as for almost all branches of more conventional scientific subjects. □

Nonprofessional employees may not be included in a voting unit with professional employees, according to a recent ruling of the United States Court of Appeals for the District of Columbia in acting on a claim by the National Labor Relations Board. □

ANNOUNCING

CROLL-REYNOLDS'

NEW Convactor



If you never heard of a CONVACTOR, do not be surprised. It is an entirely new design of special condensing tower which offers important advantages in some processes.

In the refining of edible oils it recovers fatty acids, most of which were formerly waste. It offers the additional advantage of totally eliminating stream pollution from this source or the expense of cleaning cooling towers which collect such deposits. It has similar application in fatty acid stills, some other types of distillation processes, dryers, and other large vacuum processing units.

The CONVACTOR is a combination of two condensers and a vacuum cooling chamber. One condenser is of conventional barometric design, the other a highly improved condenser working on the jet principle. The latter condenses the vapor from the process and discharges directly into the vacuum cooling compartment where the heat of condensation is immediately removed. The cold water is then recirculated through the same jet condenser. The flashed vapor from the cooling operation is condensed in a conventional barometric condenser using water from a river, cooling tower or other industrial source. Periodic blow-down or continuous bleed-off from the flash chamber permits recovery. Several large industrial installations have been made.

It is significant that this new contribution to vacuum equipment should come the year we are celebrating our Fortieth Anniversary.

CROLL-REYNOLDS

Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

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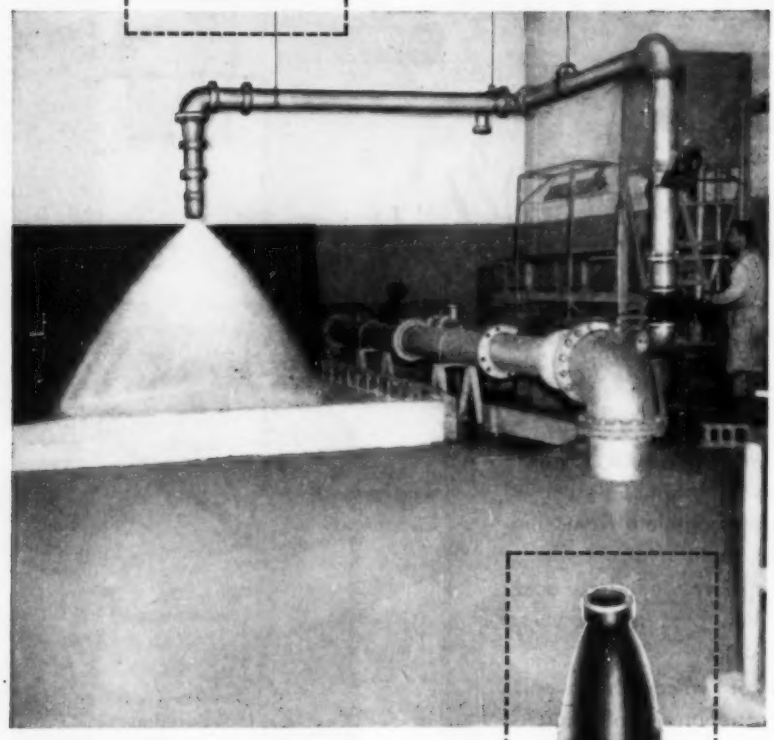
CHILL-VACTORS • STEAM-JET EVACTORS • AQUA-VACTORS • FUME SCRUBBERS • SPECIAL JET APPARATUS

SPRACO nozzles



Performance test in one of the country's largest hydraulic laboratories. 6-inch Spraco full cone nozzle spraying 720 GPM at 10 lbs. pressure. Spraco performance data on all types of nozzles is extremely comprehensive and accurate. Inset shows a 1½-inch full cone nozzle.

SPRACO
full cone spray nozzles

IN STOCK — the most complete range of sizes and capacities available anywhere.

IN BRASS, BRONZE, STAINLESS STEEL, or (on special order) in any machineable metal.

PATTERN — uniform, even distribution, — wide angle down to sharp angle.

REPLACEABLE CORE — in spraying highly corrosive liquids at high pressures worn cores are easily replaced.

FLAT SPRAY and HOLLOW CONE SPRAY nozzles are also available from stock.

For complete catalog, Write:

SPRAY ENGINEERING COMPANY

132 Cambridge St., Burlington, Mass.

INSTITUTIONAL NEWS

A.I.Ch.E. NUCLEAR ENGINEERING DIVISION INSTALLS '58 OFFICERS

The officers of the Nuclear Engineering Division of A.I.Ch.E. for 1958 were installed during the annual meeting of the Institute at Chicago in December. Election results of this relatively new division point up the universal interest of government, private industry, and educational establishments in this field. New officers are: Kenneth W. Davis, U. S. Atomic Energy Commission, chairman; John W. Clegg, Battelle Memorial Institute, vice-chairman; Charles E. Dryden, Chemical Engineering Dept., Ohio State University, secretary-treasurer; and Charles F. Bonilla, Chemical Engineering Dept., Columbia University, executive committee.

Senior postdoctoral fellowships in science are announced for 1958 by National Science Foundation. Awards will be made March 18, 1958, to qualified individuals at least five years beyond doctorate in science or equivalent, to supplement training. Those interested may apply to Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C. □

The Institution of Chemical Engineers, London, England, has joined the European Federation of Chemical Engineering. In addition to the new English affiliate, the Secretariats of the Federation are DECHEMA, Deutsche Gesellschaft fuer Chemisches Apparatewesen, Frankfurt am Main; and Societé de Chimie Industrielle, Paris, France. □

Fellowships with stipends of from $1,500 to $2,100 plus tuition and fees for graduate engineering and fundamental research in plastics are open at the Graduate School of Princeton University. For further information and application forms, address Prof. Louis F. Rahm, Director, Plastics Laboratory, Princeton University, Princeton, N. J. □

In honor of the late dean of the University of Michigan's College of Engineering, a group of engineering buildings proposed for the North Campus will be known as "The George Granger Brown Memorial Laboratories." The new facilities will include a laboratory for fluids engineering, another for materials, metallurgy, and structures, and a highway laboratory. □

BEN BUTLER (right), West Coast Production Manager, Borden Company Chemical Division. Left, Bernard Egan, Alaskan Copper & Brass Co., Cooper Alloy distributor for the Pacific Northwest.

BUTLER OF BORDEN CHEMICAL

tells why he buys COOPER ALLOY stainless steel valves

Q. Mr. Butler, why does Borden Company Chemical Division require stainless steel valves?

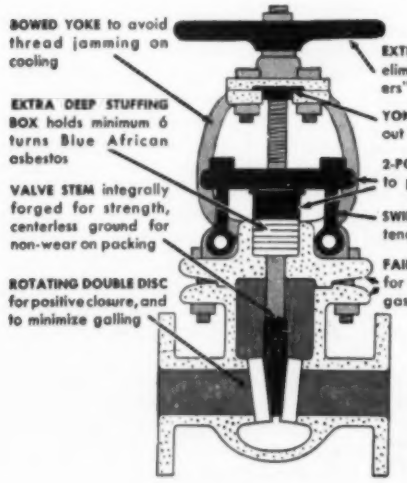
A. In the manufacture of formaldehyde, its derivative resins, and corresponding industrial adhesives only stainless steel can meet our rigid requirements for corrosion, contamination and heat resistance.

Q. What do you consider the most important factor in purchasing valves?

A. The truest measure of a valve is its operating performance. We have never received a complaint on Cooper Alloy valves from our engineers or operating personnel. The extra-large handwheel and unique valve design afford easy operation with positive opening and closing, minimizing maintenance and down time.

Q. What other factors count in choice of valve supplier?

A. Service. The large and complete Cooper Alloy stock at Alaskan Copper affords immediate delivery on stainless steel valves and fittings, as well as pipe. That's a big reason why we buy Cooper Alloy!


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
FAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: *"You can tell a Cooper Alloy Valve as far as you can see it!"* Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

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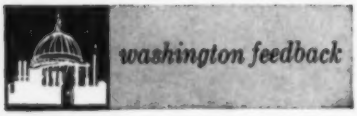
VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING



Joseph L. Gillman, Jr.

The time of the "restrained crisis"

Washington, as the daily press indicates, is in the usual state of excitement which precedes and carries through the first few weeks of a new session of Congress. At this time there is, however, an undercurrent different from that of opening sessions in the recent past: there is a state of what one journalist has called "restrained crisis" in which leaders in government are more or less maintaining an outer calm while dealing with the combined stimuli of two sputniks and at least the first stages of an uncertain business situation.

Mr. Killian, the hope of the technologist, still seems to be engaged in a staff-advisory role to the President. Despite the suggestions by many writers—and Congressmen, for that matter—that he play a more decisive role, no encouragement of this kind appears from the direction of the Pentagon, the largest single establishment which would be affected by any strengthening of Mr. Killian's authority.

The announced resignation of the Army's Chief of Research and Development, General Gavin, has stirred up a storm among those who would like to look into the resignation of such a high official for factors of significance in today's "restrained crisis."

Branch Office: Washington

Increased attention is being given the Nation's Capitol by big business, according to several indicators. One of the oldest and most conservative real estate management firms in the national capital reports extremely active interest in new office space by national concerns seeking to set up or expand their Washington operations. Companies engaged in oil, missiles, electronics, and public relations are among those seeking significant units of space. From the public-relations standpoint, Donald M. Bernard, v-p of Public Affairs for the well-informed *Washington Post*, reports that "some institutional advertising has already appeared and considerable interest is being displayed on the part of others in the missile and defense fields, intended primarily to attract the attention and to get the eye of the factors in government that have much to do with the letting of contracts, with buying, and with the expanding of markets."

Salary Carousel

The subject getting the most discussion mileage among technologists in Washington is the recent pay increase authorized on December 9 for selected categories of Civil Service engineers and scientists which will cost the taxpayers $25 million.

It is significant that the request for these pay increases came from the Department of Defense, the biggest user of engineers and scientists in the Federal Government. While the move is part of a recruiting program to bring 4,000 more technologists into government service, it automatically benefits 48,000 already employed, and hence, will help to hold them.

A Civil Service Commission spokesman said they believe this raising of salaries "will help get and hold a fair share of engineers and scientists." He doubts that it will fill all of the current needs, but feels that it is definitely a move in the right direction.

Already there are notes of discord. Some technologists not included among those being benefited are complaining that their failure to get the raise is *prima facie* evidence that their professions are not as highly regarded by the government as engineering or physical science.

One scientist of international reputation who holds a high position in the scientific world as well as in government feels that this "across-the-board" raise does an injustice to some and gives an undeserved bonus to others. He feels that the big problem lies with the upper level of men already at the top of their Civil Service grade who are now bumping their heads against an immovable ceiling.

A high ranking military officer believes that the young technologists are not attracted to government service in spite of a satisfactory entrance pay level because there appears to them to be no future in Civil Service. He says he is well aware that the government can never match industry salarywise for either uniformed or civilian employees, hence, something should be offered as a substitute for a higher monthly pay. He recommends:

- **Stability of employment.**
- **Proper climate for work in the form of good associates and pleasant surroundings.**
- **Positions with dignity, honor, and respect.**
- **Salaries that will insure reasonably good family life.**

The head of the chemical division of one of this government's very important laboratories says that industry is continually luring men from their organization to do the very job they have been doing for the government. These men get from 10 to 25% more salary in industry, but almost invariably express dissatisfaction from having less responsibility and less work.

Most individual government engineers who have some years in service look upon this raise as "money in their pockets." They don't feel that they should be expected to do more than they have already been doing for the primary reason that they have always felt that they have been underpaid. They feel that the government has a long way to go to catch up. Paul S. Forsyth (member A.I.Ch.E.) in the Office of the Assistant Secretary for Defense (Research and Engineering) feels that "the connotation of increased prestige that goes with the pay increase does more to hold the engineer than the monetary value of the raise." He is of the opinion that "most government engineers realize that they will never be paid as much as industry would pay for corresponding responsibility. It is the challenge of a government job that stems from the magnitude of the assignments and the great responsibility to the nation that holds a man. If the government would raise the salary level of professional engineers enough to relieve those without outside incomes to a worry-free level and would, in addition, gauge the treatment of the individual by his relatively great responsibilities, the Government would promptly fill its engineering billets with competent people."

Dr. Emerson P. Schmidt, Director of Economic Research, U. S. Chamber of Commerce, had this statement to make: "Paying existing personnel more money won't necessarily make them more productive: only if a higher pay scale will hold and recruit more competent people so that the increased pay is offset by improved productivity would an increase in pay be justified."

In summary, the situation looks this way: The Defense Department needs scientists. The existing pay scale won't attract them. They appeal to the Civil Service Commission which raises the pay to the limit of the law. This act, they hope, will attract new people from industry (meanwhile giving a bonus to others). Defense will then let contracts to the same concerns from whom they have just lured technologists. These concerns, operating on a cost-plus basis, may very well try to raise the ante to hold onto, or to get back from government the technologists which would enable them to fulfill these contracts.

SPARKLER
horizontal plate
FILTERS

Undisputed First Choice

with engineers who have had occasion to thoroughly test this type of filter. Shown here are structural features that are the result of over 30 years experience in building this one filter.

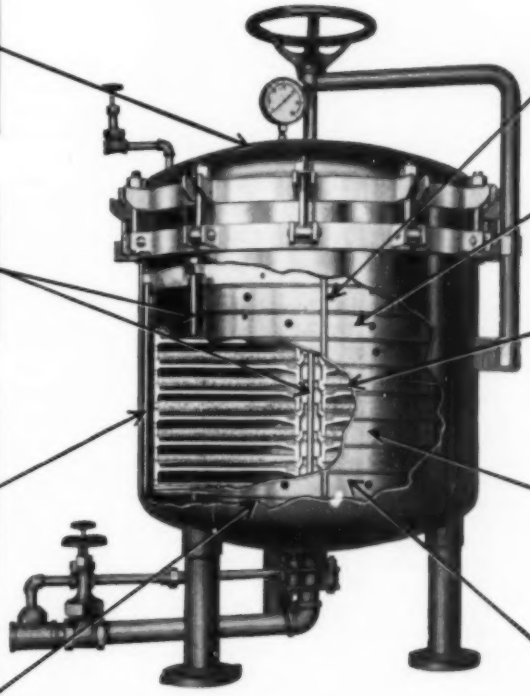
Aloysius C. Kracklauer
Originator of the Horizontal Plate Filter

A.S.M.E. designed construction is standard for pressures up to 60 lbs. on all filter tanks.

Plates sealed independently at center and periphery to assure positive seal.

Plates sealed independent of tank closure to secure a positive seal for both filter plates and for tank cover.

Scavenger plate supported by re-inforced flat bottom tank.



Cartridge plate assembly—removable independently of tank.

Heavy solid plate rings precision machined.

Heavy perforated sheet metal support for filter paper.

A more positive filter seal is obtained when hydraulic pressure is applied to plates externally rather than internally.

Plate designed to reduce flow friction to a minimum.

SPARKLER FILTERS

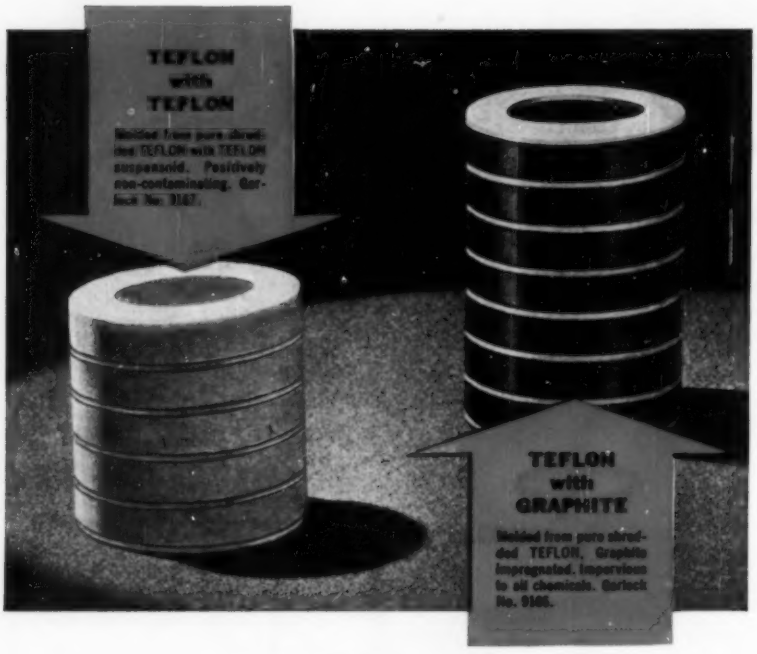
The Sparkler, original exclusive horizontal plate design and flow principle, has never been equalled for efficiency and dependability in filtering with any and all types of filter aids. The cake maintains its original position as formed regardless of pressure fluctuation flow rate or viscosity. No break-through is possible, even with a complete shut down of the filter. Filtering can be resumed with perfect safety at any time. With Sparkler plate construction a completely sanitary filter can be furnished.

SPARKLER MANUFACTURING CO. MUNDELEIN, ILLINOIS

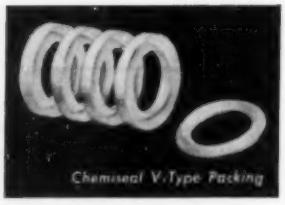
Sparkler International Ltd.—Manufacturing plants in Canada, Holland, Italy and Australia.

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

CHEMISEAL® PUMP PACKINGS
standard for corrosion service . .



. . good for all chemicals



FOR VALVES

Solid TEFLON Ring packings are available in Chemiseal V-type, diagonal, triangular, conical and Garlock Chevront ring designs—providing necessary seal at low gland pressure and reducing torque required to operate the valve.

Chemiseal TEFLON* Pump packings offer remarkably trouble-free service, and useful life many times that of other type packings.

Impervious to all chemicals, excepting only molten alkali metals and fluorine at elevated temperatures, these packings are giving highly satisfactory performance sealing against such difficult and hazardous liquids as sulphuric, chromic, nitric and hydrofluoric acids; chlorine, bromine, sulphur chloride, sulphur oxychloride, hydrogen fluoride and concentrated hydrogen peroxide.

Extremely effective for rotating and reciprocating shafts, Chemiseal TEFLON pump packings provide a low friction, 2-way seal that not only prevents axial seepage, but also seals against shaft and stuffing box as well. Supplied in sets to meet specific requirements.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write for Bulletin AD-155.

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United States Gasket *Plastics Division of* GARLOCK

OVERSEAS NEWS

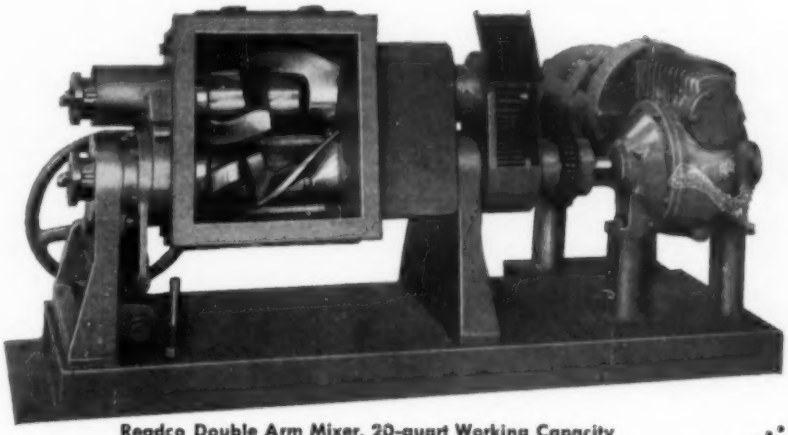
An exclusive agreement has been signed between Fluor Products Co. and Maschinenfabrik Hartmann A.G., Offenbach, Germany, according to which Fluor will design, manufacture, and sell the German firm's line of heavy duty industrial pneumatic and mechanical conveying systems, ash handling systems, dust removal and classifying systems. □

Headquartered in Switzerland, newly formed Vitro International will represent all overseas operations of Vitro Corporation of America. Present foreign commitments of Vitro abroad include design and construction of a nuclear test facility at Milan for the government of Italy, a heavy water-fertilizer plant for the government of India at Nangal, and a large nuclear power station for SIMEA, a government-owned corporation, near Rome, Italy. □

Titanium dioxide will be produced in Mexico in a $6,500,000 plant to be built by Industrias Quimicas Basicas de Mexico, S.A., in the state of Veracruz. Initial capacity is set at 8,000 tons/year, expansion to 12,000 tons/year is projected. Process, plant design, and technical assistance will be furnished by Glidden Co., Baltimore, Md. Production facilities will include a 100 ton/day sulfuric acid plant, raw materials will be native Mexican ilmenite and sulfur. The venture will be entirely Mexican-owned, no foreign investment capital being involved. □

Fifty thousand tons per year of titanium dioxide will be produced in West Germany in a new plant to be erected at Uerdingen/Krefeld by Farbenfabriken Bayer AG. □

Eighteen ton resorber shown above is part of a multiple-component resorber system being designed and fabricated by Barnebey-Cheney for Acetafil, S.A., Havana, Cuba. The stainless-clad unit will contain 17,000 pounds of coconut shell carbon, is part of a synthetic acetate fiber plant which is under the technical management of Von Kohorn International Corp.



Readco Double Arm Mixer, 20-quart Working Capacity

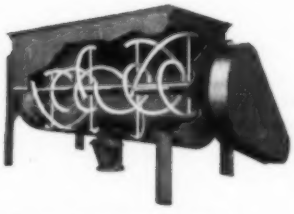
Predict production precisely with READCO Lab and Pilot Plant Mixers

READCO

Incorporating all the basic design features of larger production models, Readco Laboratory and Pilot Plant mixers enable you to make accurate forecasts for commercial processing.

Mixing bowls are accurately machined and fitted . . . have vacuum covers and code jackets. Overlapping sigma mixing arms are held in constant close clearance, eliminate dead spots, prevent build-up of materials, aid temperature control. Easily interchangeable mixing arms adapt to various materials or processes.

Ruggedly built of Type 316 stainless steel, or any commercial alloy, Readco lab and pilot plant mixers will efficiently handle even heavy viscous material. They are available from stock in 1, 3, 6, 20 and 40-quart working capacities, with fixed or variable speed drives. For more information see Chemical Engineering Catalog, pages 1483-1490 . . . or write direct.



Readco Spiral Ribbon Mixers—Batch or Continuous. Standard sizes 1 to 500 cu. ft. working capacities.

Readco Vertical Mixers, planetary action, multiple speed, 12 to 175 qt. working capacities. (Model K-20 illustrated)

Whatever the mixing job . . . a READCO mixer!

READ STANDARD

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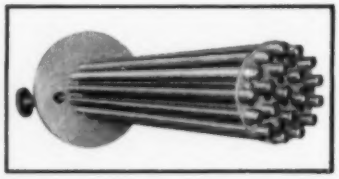
Capitol Products Corporation

Fansteel
Corrosionomics
REGISTERED U. S. PATENT OFFICE
A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

TANTALUM BAYONET HEATERS CUT ACID PROCESSING COSTS



Fansteel tantalum bayonet heaters come in a wide variety of sizes and shapes to fit the most critical need.

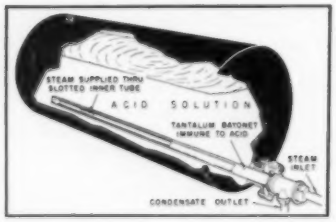
Tantalum bayonet heaters are the most economical heating units obtainable for extremely corrosive acid solutions (except hydrofluoric and fuming sulfuric). This can be proved on a cost reduction basis if all the factors of highly corrosive service are carefully considered.

Acid Proof—Long Life

Fansteel tantalum bayonet heaters are ideally suited to acid processing requirements for several reasons. First, the pure metal is not subject to thermal shock. It is acidproof, not just acid-resistant—which makes product contamination impossible. Fansteel tantalum also has high tensile strength, compressibility, impact strength and ductility. Since no corrosion allowance need be made, only the thickness required for structural strength need be used.

High Processing Rates

Acid processing rates are very high with Fansteel tantalum heaters. The special design permits rapid removal of condensate on the steam side, promotes high velocities of both steam and condensate, and keeps the condensate film at minimum thickness. The heaters are never flooded and air can be discharged readily with the condensate. Added to this is tantalum's high rate of heat transfer which further speeds processing. Overall coefficients of 500 to 1200 are commonly obtained.



For vessels with side or bottom openings, the bayonet heater is an effective unit (single or multiple tube). Steam enters through the inner steel pipe, escapes through slots near the end and heats the tantalum tube.

Overall Economy

These characteristics combine to make tantalum the ideal material for use in critical pieces of equipment such as heaters. The initial cost is more than justified by long, trouble-free service, simplicity of design made possible in associated equipment, and even upgrading equipment with heaters made from other materials. Heating capacities and standard sizes of Fansteel single-tube, bayonet heaters are shown in our Bulletin 3.506. They are also listed in the Chemical Engineering Catalog, page 750.

Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, if requested on your letterhead; contains both tantalum sheet and wire.

Free Technical Information

The above condensation is typical of the articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our free mailing list.

G581A

For further data on the above, write:

FANSTEEL METALLURGICAL CORPORATION
CHEMICAL EQUIPMENT DIVISION
NORTH CHICAGO, ILLINOIS, U. S. A.

OVERSEAS NEWS

Production of nitrous oxide and cyclopropane has started at two new Cleveland plants of Ohio Chemical & Surgical Equipment Co., a division of Air Reduction Co. Combined annual capacity will be 240 million gallons of nitrous oxide and 9 million gallons of cyclopropane. Capital investment for the two plants was in excess of $1 million, engineering supervision was by Air Reduction. □

Precision potentiometers, components for electronic systems and instruments will be manufactured in an under-construction plant of Beckman Instruments, Ltd., at Glenrothes, Scotland. The new Scottish plant, near the Firth of Forth in the County of Fife, is slated for start-up in February, 1958. □

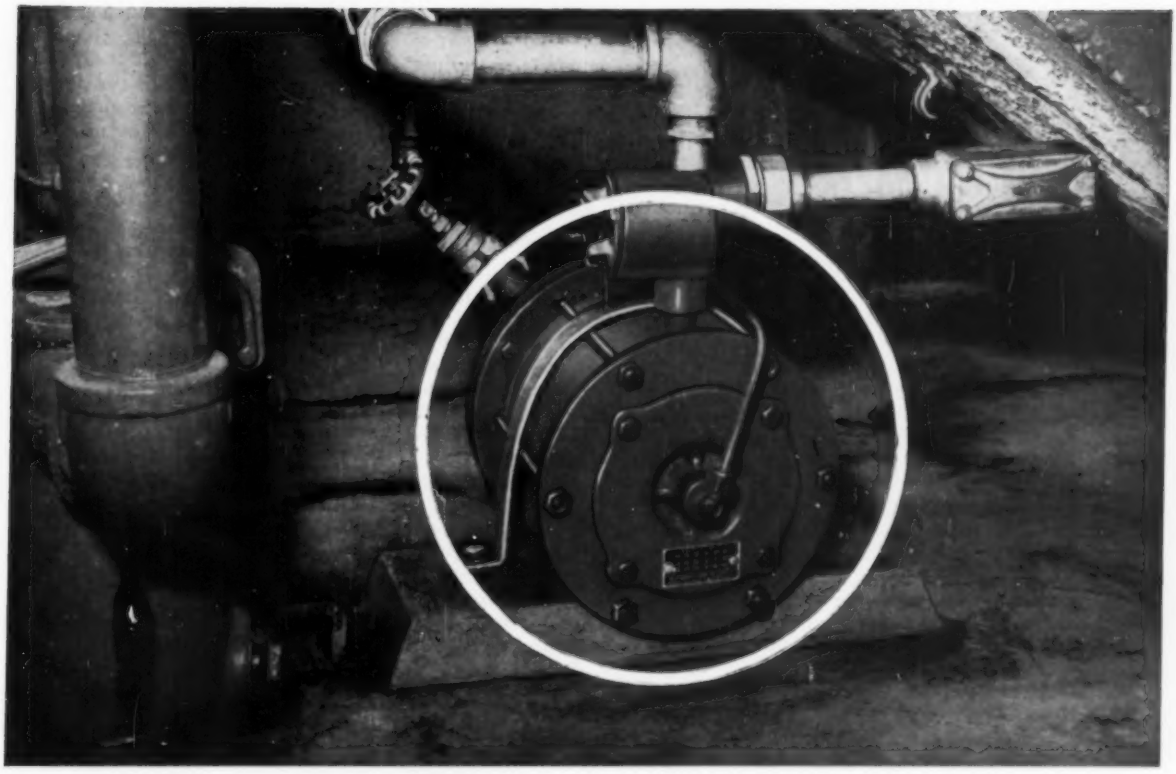
A Hong Kong foreign sales office has been opened by Dow Chemical International, export subsidiary of Dow Chemical. □

Licensing agreements have been concluded for construction of a Houdry dehydrogenation process unit by ANIC of Italy, says Houdry Process Corp. The ANIC plant at Ravenna, Italy, where ANIC is building plants for synthetic rubber and nitrogen fertilizers, will have a nominal design capacity of 20,000 tons/year of butadiene. ANIC is controlled by E.N.I. (Ente Nazionale Idrocarburi), economic agency of the Italian state, which is sole lessee in prospecting, extracting, and transporting oil and gas in the Po valley. □

A new neoprene plant is underway in Londonderry, Northern Ireland. Builder is Du Pont (United Kingdom) Limited. □

A new Esso refinery in Trieste, Italy will turn out high octane fuels. Equipment fabrication and plant construction is by Compagnia Tecnica Italiana Petrolio. □

Ultra-high purity elemental silicon will be made in Puerto Rico by International Metalloids, Inc., Puerto Rican subsidiary of Grace Internacional S.A. Formation of the new company follows an agreement between Grace and Pechiney of France, owners of the process to be employed. Start-up will be in early 1958, annual capacity is set at 20,000 pounds. Current price of the grade of silicon to be produced is about $360 per pound. □



Chempump eliminates fire hazard

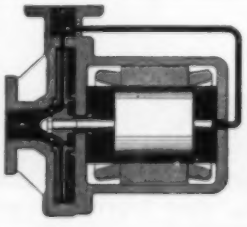
handling acetone and naphtha at Vi-Jon Laboratories

This *Chempump* moves a highly inflammable mixture of acetone and naphtha in the manufacture of chemical specialties and cosmetics at Vi-Jon Laboratories' St. Louis plant. The conventional pump it replaced leaked continually at the packing gland, creating a fire hazard. The leakproof *Chempump* solved this serious problem.

For Vi-Jon Laboratories, *Chempump* means maintenance economy as well as safety. The company reports there has been absolutely no maintenance on the pump. "It was installed and forgotten, as far as maintenance is concerned."

With *Chempump*, hard-to-handle fluids can't leak—in or out—because there are no seals, no stuffing box, no packing. Occasional inspection and replacement of bearings is the only care required. External lubrication is never needed—bearings are constantly lubricated by the pumped fluid itself.

Leakproof fluid handling with *Chempump* offers many other advantages well worth your investigation. For details, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.



Chempump combines pump and motor in a single, leakproof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

Chempump

First in the field...*process proved*

PAY, PROFITS, AND PROFESSIONAL STATUS

The purely human facets of the engineer's character—his professional and personal goals, his need to escape from the effects of over-organization, his right to promotion on the basis of talent rather than mere seniority—were the subject matter of the opening panel discussion at A.I.Ch.E.'s recent Annual Meeting in Chicago.

A blunt warning led off the panel on Providing a Good Working Climate For the Engineer in Industry. "The establishment of a professional climate for engineers," said C. W. Muhlenbruch of Engineer and Technical Consultants, "is a crucial problem and it will be the key issue for American industry during the next five years." Muhlenbruch defines a professional climate as "the cultivation of that conscious attitude which leads to the engineer's possessing integrity, competence, sincerity, loyalty, and an overall ethical sense." Since a professional climate and its maintenance is more a matter of heart than head, continued Muhlenbruch, it behooves the plant supervisor to wake up and look for the hidden potential in his men; to forget the "professional piffle" (fringe benefits, office carpeting, etc.); and to get to know the "whole man" in the men under him. The speaker also suggested a new twist in coffee breaks—a period during which engineers could speak before their co-workers "on any subject from cathodic protection to Bach."

Employment Stability

Why do engineers leave home? "Over-organization can make for a caste system far more readily than under-organization," emphasized Eimco's D. A. Dahlstrom. In his analysis of the "Company vs. the Individual Problem," Dahlstrom pinpointed failings on both sides. On the company side: imposition of too much conformity; insufficient delegation of power down the line; poor communications; failure to treat the engineer as an individual. On the other side of the coin: *no effort on the part of the company can help an individual engineer who has no goals of his own.*

Real Engineers

Industry should concern itself only with "real engineers," stated M. T. Carpenter of Standard Oil, speaking on "Engineer-Manager Relations." He went on to add that "school plus a mere degree does not make an engineer." Carpenter stressed the right of the engineer to full information on all aspects of company policy—patent rewards, leaves of absence, educational assistance, general company objectives, and most important, his own position in the company hierarchy. "If management has a good communication program," said Carpenter, "there need be no union. As a rule, there should be no unions in the professions, and true professional status should be the goal of every chemical engineer."

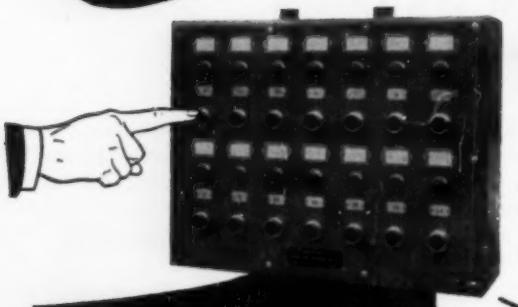
Higher Salaries—Higher Profits

"Companies who pay the most earn the most. Top companies are oriented toward the individual and his performance; low companies are oriented toward seniority." This conclusion, said Arch Patton (McKinsey & Co.), is based on a statistical survey of thirteen top companies; without exception, he added, these companies pay the highest salaries and base their salary policies on the reward-to-talent-and-merit school of thought. "Demonstrated performance," concluded Patton, "should be the key to salaries—not seniority or years out of school."

NOW PUSH BUTTON CONTROL

FOR DISTRIBUTION OF

DRY BULK MATERIALS



Do you ever wonder if your distributor is set on the right bin? The new FOOL-PROOF Hayes & Stolz Electric Distributor removes all doubt by signalling accurately your loading position at all times. Position can be changed only by a numbered push-button on the control panel, assuring positive selection. The new H & S Electric Distributor can be fitted with 5 to 20 openings. The diameter of these openings can be specified in 6", 7", 8" 10" and 12" sizes. Adaptable to mounting on elevator legs, collectors, sifters, mixers, screw conveyors and belt conveyors.

H S Electric Distributor

CAN BE CUSTOM-BUILT IN ALL SIZES TO FIT YOUR PLANT NEEDS

Extra monitor panels are available to allow for check on settings from anywhere in your plant.

Engineered with care and fully backed by HAYES & STOLZ WARRANTY

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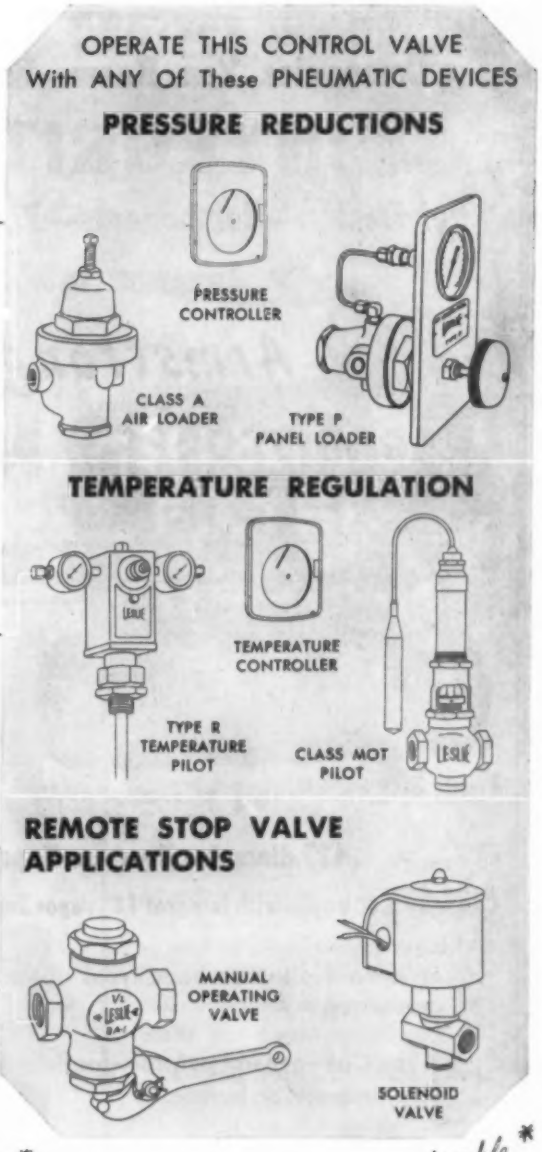
A NEW LESLIE FINAL CONTROL ELEMENT

packless!*

A REALLY VERSATILE CONTROL VALVE — with only two moving parts and a metal diaphragm*



Now, simplified instrumentation combines the simple air loaded, Leslie diaphragm operated valve with various air operated devices. This is the valve that filled a real need when introduced about a year ago, wearing a 3-year guarantee against maintenance in normal pressure reducing services.

This new final control element is gaining wide acceptance for use with a variety of pneumatically operated controllers — simplifying pressure reductions, temperature regulation, remote stop valve applications and many process steam control services.

Ideal for "problem" installations

This control valve is ideal for either continuous or intermittent service and has remarkable immunity to dirty steam. Furnished in cast iron, sizes ½ - 2", it is suitable for any steam service up to 250 psi, 450F, and many fluid services.

It's simple — it's accurate

This Leslie control valve has only two moving parts ... no fussy seals, no stuffing boxes, no small dirt-catching parts; yet, with all its simplicity, it provides uncanny accuracy with its double* feed-back action. It lends itself readily to remote adjustment, too.

More Information

Ask your Leslie engineer to tell you more about this really versatile valve and the simplified instrumentation "packages" now available. You'll find him listed in your classified directory under "Valves" or "Regulators" and eager to come up with new ideas for simplifying pressure, temperature and liquid level control systems.

Send for Bulletin 561-A

* These are the President's comments — even the ad manager didn't know all the fine features!

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INTEGRITY

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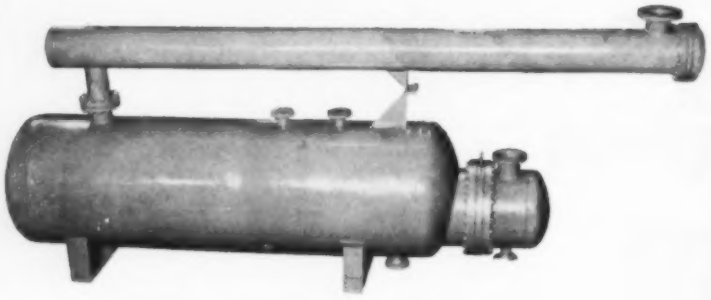

42″ diameter Propane Vaporizer

Capacity 5,000 gph. with integral 12″ vapor Superheater overhead

We make also two basic types of vertical bayonet vaporizer.

Type One—general purpose—for field use in vaporizing propane or butane.

Type Two—heavy duty—using TEMA R type of construction for refinery or chemical plant construction.

Heavy Duty Type built specially to suit the individual case; rugged refinery construction, well suited to both Chlorine and Ammonia.

The more exacting you are—the more "You Can Rely on Armstrong" to solve your vaporizing problems.

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future meetings

■ 1958 MEETINGS

A.I.Ch.E.

• Chicago, Ill., March 17-21, 1958. **1958 Nuclear Congress.** Managed by A.I.Ch.E. Coordinated by E.J.C. Will include: 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference.

• Montreal, Canada, April 20-23, 1958. Sheraton-Royal Hotel. **Joint A.I.Ch.E.—C.I.C. Conference.** Following symposia will be presented: **Chemical Engineering Education in the U.S. and Canada**—noted educators from both countries will discuss present practice, probe future needs. **The Chemical Industry in Europe Today (3 sessions)**—including two speakers from the Soviet Academy of Sciences. **Statistics in Chemical Engineering**—accomplishments and limitations of statistics in chemical engineering. **Chemical Engineering in the Pulp and Paper Industry**—continuous chemical pulping, new methods for chlorine dioxide manufacture. **Chemical Engineering in Mineral Processing**—impact of chemical engineering on an already highly-developed art. **Modern Engineering Construction Techniques**—use of digital computers and small-scale plant models. **Chemical Engineering Problems in Heavy Water Reactors**—natural vs. enriched uranium, heavy water production problems. **Relationships Between Investors and Chemical Industry Management**—analysis of today's key problem—the profit squeeze. **Fluid Mechanics (2 sessions)**—special emphasis on pulp and paper problems. **General Technical Papers (2 sessions)**—several on various aspects of heat transfer. **Future Sources of Energy**—solar energy, high-energy chemicals. **High Temperature Materials for Jets and Rockets**—most recent available data. **Noise in the Chemical Industry**—hazards, methods for measurement and control.

See also page 120 of this issue.

• Berkeley, California, June 19-21, 1958. Dwinelle Hall, University of California. **1958 Heat Transfer and Fluid Mechanics Institute.** Co-sponsored by A.I.Ch.E. and other groups.

• Philadelphia, Pa., June 22-27, 1958. Bellevue-Stratford Hotel. **50th Anniversary Jubilee Meeting of A.I.Ch.E.** Theme for the meeting is "A Look to the Future." The program is planned to present the gaps in today's knowledge—both theoretical and practical—and to chart the steps needed to promote the most rapid growh of chemical engineering. For details see also page 117.

• Evanston, Ill., August 18-21, 1958. **A.I.Ch.E.-A.S.M.E. Heat Transfer Conference,** Northwestern U. Technological Inst. Tech. Prog. Chmn.: A. S. Foust, Dept. of Chem. Eng., Lehigh University, Bethlehem, Pa. Deadline for papers: March 15, 1958.

• Salt Lake City, Utah, Sept. 21-24, 1958 Hotel Utah. **A.I.Ch.E. National Meeting.** Tech. Prog. Chmn.: E. B. Christiansen, Dept. of Chem. Eng., Bldg. 437, Univ. of Utah, Salt Lake City. **Air Pollution**—W. L. Faith, Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, California. **What's New in Liquid Metals Technology**—Marshall Sittig, American

Lithium Institute, Inc., P.O. Box 549, Princeton, N.J. **Crystallization**—H. M. Schoen, American Cyanamid Co., 1947 West Main St., Stamford, Conn. **Foams and Froths**—J. Louis York, Dept. of Chemical Engineering, Univ. of Mich., Ann Arbor, Mich. **Ethylene**—Hermann C. Schutt, 201 Devonshire Street, Boston, Mass. **Polar-Nonpolar Thermodynamics**—J. M. Smith, Dept. of Chem. Engr., Northwestern Univ., Evanston, Ill. **Petroleum Substitutes**—J. M. Hirsch, Gulf Research & Dev. Co., P.O. Drawer 2038, Pittsburgh 30, Pa. **Filtration and Centrifugation**—J. O. Maloney, Univ. of Kansas, Lawrence, Kansas. **Intermountain Industries**—W. C. Bauer, Intermountain Chem. Corp., Box 872, Green River, Wyoming. **High Temperature Chemical Kinetics and Transport Phenomena**—W. R. Marshall, Univ. of Wisconsin, Madison, Wis. **Dry Classification of Solids**—D. W. Oakley, Metal and Thermit Corp., Carteret, N. J. Deadline for papers: May 21, 1958.

• Cincinnati, Ohio, December 7-10, 1958. Netherland Plaza Hotel. **A.I.Ch.E. Annual Meeting.** Tech. Prog. Chmn.: A. C. Brown, Emery Industries, Inc., June & Long Streets, Ivorydale, Ohio. **Liquid Industrial Wastes**—C. Fred Gurnham, Dept. of Chem. Engr., Michigan State U., East Lansing, Michigan. **Distillation**—W. C. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. **High-Speed and Time-Lapse Photography in Chemical Engineering**—J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. **Kinetics & Rate Processes**—H. E. Hoelscher, Dept. of Chem. Eng., John Hopkins Univ., Baltimore 18, Md. **Reprocessing of Fluid Reactor Fuels**—O. E. Dwyer, Chem. Eng. Div., Brookhaven National Laboratory, Upton, L.I., N.Y. **The Application of Computers to Heat and Mass Transfer Problems**—J. M. Smith, Northwestern Univ., Evanston, Ill. **Low Temperature Processing**—C. McKinley, Air Products, Inc., Allentown, Pa. **Applied Heat Transfer**—W. W. Akers, Dept of Chem. Engr., Rice Institute, Houston, Texas. **Scale-up from Pilot Plant to Plant**—D. B. Coghlan, Foote Research and Development Laboratories, Berwyn, Pa., R. A. Schulze, DuPont Chambers Works, Jackson Labs., Penns Grove, N. J. **Guideposts in Long Range Planning**—H. E. Wessel, Monsanto Chem. Co., 1700 South Second St., St. Louis 4, Mo. **Fundamentals of Spraying and Spray Equipment**—J. F. Tourtellote, Swenson Evaporator Co., 18505 James Couzens Highway, Detroit 35, Mich. Deadline for papers: August 7, 1958.

NON-A.I.Ch.E.

• Ann Arbor, Mich., January 30-31, 1958. Univ. of Mich. **10th Annual College-Industry Conference.** Sponsored by the American Society for Engineering Education. Subject of conference will be "New concepts in the education and development of technical manpower."

• Brussels, Belgium, May 28-29, 1958 and Frankfurt am Main, West Germany, May 31—June 8, 1958. **Congress of the European Federation of Chemical Engineering.** Papers will deal with recent results in research and development.

UNSCHEDULED SYMPOSIA

Proposed, but unscheduled, symposia of the Institute may be found listed in November CEP, page 180. Correspondence on proposed papers is invited by the symposia chairmen.

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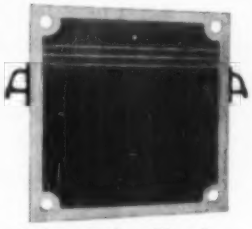
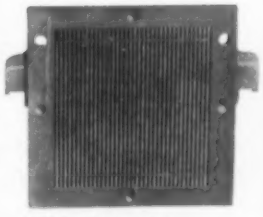
Large filter press with rubber-covered cast iron plates and frames.

SHRIVER FILTER PRESSES



Polyester plate fiberglass-reinforced.



Solid rubber plate.

Stainless steel plate.

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• The Equipment
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To meet any corrosive, abrasive or other conditions during filtration which may be destructive to equipment or harmful to purity and quality of the material being processed, Shriver Filter Presses can be supplied with plates and frames.

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The factors of suitability, first cost, strength and available filtering area must be considered specifically for each application.

We'll be glad to consult with you on the best means of "protective" filtration.

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FILTER PRESSES • VERTICAL LEAF FILTERS • FILTER MEDIA
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The American Institute of Chemical Engineers announces . . .

THE GOLDEN JUBILEE OF CHEMICAL ENGINEERING

To be celebrated
June 22 through June 27
at Philadelphia, Pennsylvania
Birthplace of the A.I.Ch.E.

For further information, write to
Local Arrangements Committee
General Chairman

William [illegible]
The Atlantic Refining Co.
Box 8139
Philadelphia 1, Pa.

JUBILEE WEEK HIGHLIGHTS

Focal point of the A.I.Ch.E.'s observance of the 50th anniversary of its founding will be the Golden Jubilee Celebration in Philadelphia, June 22 through 27, 1958. Highlights of the extensive ceremonial, technical, and social programs will be:

- *A Ceremonial Session*—to be addressed by a major representative of the U. S. Government, and attended by a distinguished delegation of chemical engineers from all over the world.

- *A Golden Jubilee Banquet*—at which Mr. Crawford Greenewalt, president of E. I. du Pont de Nemours & Company, will speak.

- *A Golden Jubilee Ball*—which will follow the banquet.

- *A unique technical program*—summarizing the accomplishments of chemical engineering over the last half century, spotlighting deficiencies in our present state of knowledge, and forecasting methods for closing these gaps.

- *A full program of plant trips*—to the Delaware Valley's busy chemical centers.

- *Plus*—plenty of time and facilities for recreation and meeting your colleagues, and a Ladies' Program to make your wife's visit memorable.

OUR PROFESSIONAL HERITAGE

"When one endeavors to trace the origin of any human institution or society," wrote John C. Olsen, first Secretary of A.I.Ch.E., "the path almost invariably leads back to some outstanding personality whose mind first conceived the need and purpose of the organization and whose initiative and industry were responsible for its early growth and development."

Olsen was referring to Richard K. Meade, "a brilliant engineer and the pioneering editor and founder of *The Chemical Engineer*. Meade first suggested, and exerted great personal influence in the founding of the new society.

His 'brave little publication' had only rounded out its first year of existence when in 1905 its editor wrote—under the title, "Why not the American Society of Chemical Engineers"—an impassioned appeal. Meade cited other professional societies as serving groups with different interests, maintained there must be "at least 500" members of this new profession. He cited training being given in "most of the leading technical institutions." Meade concluded that "a society formed of such men could not fail to be of benefit."

As is often the case, not much happened after publication of this editorial, except that Meade remained unceasing in his efforts to gain support for his ideas. Not to be discouraged, he reprinted the editorial in March, 1907. This time, he followed it with personal letters to fifty or more leading members of the profession. Olsen reports that Meade then "found willing support in a growing sentiment that there was a real need for a . . . society with high ethical and professional requirements for membership . . ." Meade subsequently called a meeting to be held during the 1907 ASTM meeting in Atlantic City, for the purpose of discussing organization.

Attending Meade's Atlantic City meeting were, besides Olsen, ten persons which included William H. Walker, Arthur D. Little, and W. M. Booth (who served as secretary), and Charles F. McKenna, a chemical engineer of great prestige, who came down from New York City to preside. This meeting established that the proposed organization could be foreseen as "maintaining highest standards," stimulating improvements in education, and exerting favorable effects toward the passage of legislation for the betterment of the patent procedure. The question "what is a chemical engineer?" kept coming up at this meeting as well as subsequent ones. In 1907, this question served to raise doubt in the minds of some that unanimity of support would be available to insure the success of a separate society. It became obvious that nothing organizationwise could be undertaken under such circumstanes, so there was appointed a "Committee of Six," to consider and develop information from members of the profession (by correspondence) on the advisability of organizing, conditions for membership, etc. McKenna was made chairman, the others being Meade, Booth, Olsen, Walker, and Little.

One of the first decisions of the new committee, reached at its meeting in New York City on July 8, 1907, was to make a mail survey of members. A list of 600 names of men known in the chemical profession was used. Eight broad questions were asked, ranging from opinions about formation of the new society, reasons why, and others having to do with entrance requirements, membership grades, etc.

About 200 replies were received. "Of these, 70 or 80 per cent were favorable to the formation of the new society," reports Olsen. However, a few prominent persons expressed the view that support should be given existing societies rather than to a new one. Although convinced that these few objections did not represent the general view of the profession, the committee felt it desirable to hold a larger and open meeting so that those in favor of, as well as opposed to the formation of a new society could advance their arguments and opinions.

A planning meeting was first held on December 9, 1907 by McKenna, Meade, Olsen, and Walker. It was decided to appoint a representative "Committee of Fifty," inviting it to meet at the Hotel Belmont, New York City, on January 18, 1908. 21 attended the meeting, and 14 expressed their views by letter. From Olsen's comments, it seems that this meeting served more to hear expressions of views than it did to produce conclusions or actions. It did authorize the Committee of Six to put the question of whether or not to organize up to the full Committee of Fifty by mail vote, sending each member a report including a full stenographic record of the discussions, a preliminary statement of membership requirements, and a statement by the Committee of Six that it concluded that the general sense of the discussion was to go ahead with the organization, publication of transactions, etc.

From this survey, 36 replies were received. 22 were affirmative, 6 negative, and 8 neutral (three of the latter saying they would join, however). The Committee of Six felt it could now proceed, and so it set the date of June 22, 1908 for a day-long organization meeting in Philadelphia. Invitations were sent to 100 whom it was thought could qualify for membership.

"Enthusiasm ran high among the 40 men who met in Philadelphia's Engineers' Club that hot June day," reports Olsen. McKenna, serving as temporary chairman, introduced Samuel P. Sadtler, who welcomed the group on behalf of Philadelphia industry. McKenna spoke on "Justification of the A.I.Ch.E." Then committees on Credentials, Constitution, and Nomination were appointed. In an afternoon session, the latter two committees reported, a constitution was adopted, and the following slate of officers was elected: president, Sadtler; first v-p, McKenna; second v-p, H. A. Hunicke; third v-p, E. G. Acheson; secretary, Olsen; treasurer, Booth; auditor, Meade.

The Credentials Committee subsequently reported all present entitled to be members. Later all were made charter members.

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PARLEZ-VOUS?

Since Montreal is the fountainhead of the two-language culture for which Canada is noted, all of the city's activities involve this duality. The traffic signs, news-stands, placards, merchandise, activities of business and social groups—practically everything that goes on has a bilingual flavor somewhere. Of the city's six daily papers, four are published in French. (One of the two English-language newspapers, the venerable morning Gazette, dates back to 1778 and none other than Benjamin Franklin had a hand in its founding.) Radio and television stations operate in either English or French. "Sens unique" and "one-way street" means the same thing to Montrealers. To the visitor from the U.S., this double-language standard usually lends an air of foreignness that almost always piques the attention and lends a sparkle to everything the visitor does and sees. It is vastly different from their own cities, where colloquial English is normally the only speech heard. But it is no barrier to the enjoyment of Montreal.

MONTREAL: C.I.C.—A.I.Ch.E. joint conference

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Montreal, Canada's largest city, is also its most diverting metropolis. Those attending the Canada-U.S. Chemical Engineering Conference, sponsored jointly by A.I.Ch.E. and the Chemical Institute of Canada in Montreal next April 20-23, will find this bilingual city compellingly different.

It is an old and romantic city. Back in 1535, Jacques Cartier, commissioned by the King of France to explore the newly discovered continent, first visited the Indian village of Hochelaga and climbed the mountain—an extinct volcano—which stands proudly and vexingly some 760 feet above the present city. He called it Mount Royal.

The view from the chalet atop the mountain is an arresting one. The St. Lawrence River, islands, harbors, the mountains (including the Adirondacks) in the distance, turbulent rapids, and greenery against modern skyscrapers—all and more fall into picture-postcard grandeur seen from this height.

On the south bank of the St. Lawrence can be seen the eastern end of the St. Lawrence Seaway project, a combined channel-deepening, canal-construction, and hydroelectric power job extending from Montreal well into the Great Lakes and designed to enable ocean-going ships to sail into the heart of the American continent.

In old Montreal, a section on the fringe of the downtown financial district, once walled and fortified against Indian raids, still remain narrow streets and some buildings which date back to the French regime. Among the banks, insurance brokerage houses, restaurants, and shops are such famous old landmarks as the Seminary of St. Sulpice, and the Chateau de Ramezy, built in 1705 by a Governor of Montreal and occupied, during the American invasion of Canada in 1775, by Benedict Arnold and later Benjamin Franklin.

Du Coté de Chez Escoffier

Montreal is justly renowned for its culinary arts and its restaurants. Within distances ranging from one block to five miles from the convention seat are such internationally known eating places as the Café au Lutin Qui Bouffe; the Cavalier Room and Le Pavillon de la Salle of the La Salle hotel; Desjardins, noted for its seafood; Drury's, specializing in English fare served in old English inn surroundings; the Eiffel Tower Restaurant; the 400 Club; Martin's; the Piazza Tomasso; Ruby Foo's; and literally scores of others.

Montreal's night life, with bistros, clubs, and dancing girls, is garish, intimate, and gay with "name" stars frequently on the programs. Husband-and-wife parties go to such clubs as the Bellevue Casino, the Chez Paree, El Morocco, and the New Orleans; the Café Mocambo, with its negro floor show, the Down Beat, which flourishes after others have closed, or the Maroon Club are the favorite resorts of "gentlemen on the town."

Busy Montreal

As a major population center of the Western Hemisphere, Montreal is a provocative beehive of engineering activity. A sum of $454,103,200 in construction contracts was awarded in the city during 1956.

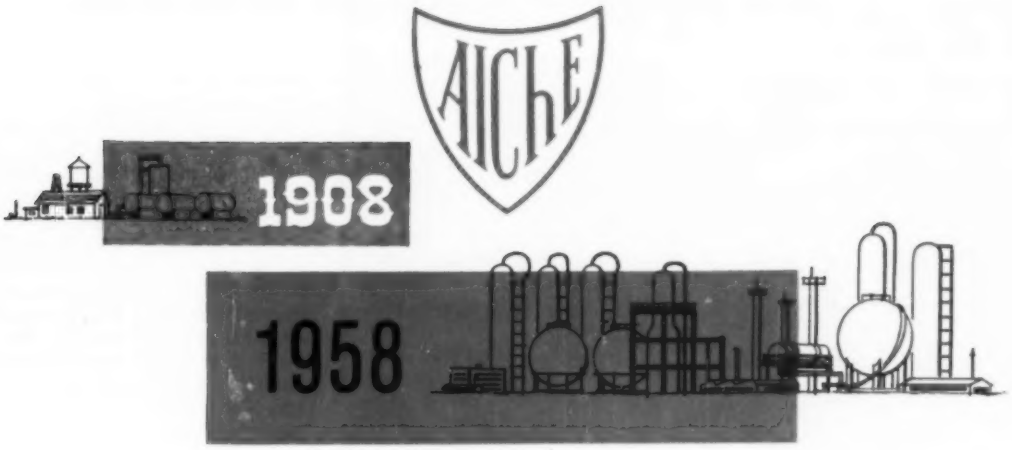
For eight months of the year, Montreal is a major harbor. Then ice closes the port. Lying 1,000 miles from the open sea, the harbor handles majestic liners and countless freighters.

Major chemical companies having Montreal headquarters include: B-A Shawinigan, Brunner-Mond Canada, Canadian Chemical and Cellulose, Canadian Industries Limited, Canadian Resins and Chemicals, Chemical Developments of Canada, Cornwall Chemicals, Consolidated Mining and Smelting, Dominion Tar and Chemical, Du Pont of Canada, Monsanto (Canada), Nichols Chemical, St. Maurice Chemicals, Shawinigan Chemicals, and Standard Chemicals.

Within the city are two universities. One, the Université de Montréal, with a student body of about 12,000, was first opened in 1876 as a branch of Université de Laval in Quebec City and became an independent university in 1920. The second is world-famous McGill University, situated where once stood the home and estate of its founder, Sir James McGill, which received its charter in 1821. Either campus is worth a visit.

Lending old-world character to the city are several farmers' markets. One is known as Bonsecours, and here haggling over the farmers' products is conducted amid jocularity that is as amusing for the visitor to watch as it is for the *habitant* to participate in.

Whether attending the Montreal Conference for the chance to share technical sessions and friendly discussions with your neighbors to the north, or frankly for the broadening experience of a visit to this most interesting metropolis, you may be assured that either way will be a pleasant, rewarding experience.



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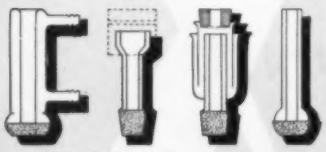

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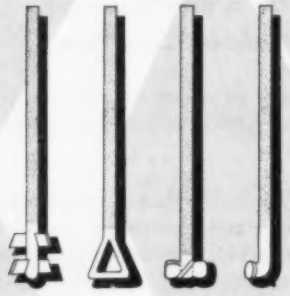

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PACKAGED NUCLEAR FUEL REPROCESSING PLANTS PROPOSED

Revenue recoup from radioactive by-products suggested as possible way out of the reprocessing dilemma.

Methods of recovering uranium and plutonium cheaply have occupied those most closely concerned with the nuclear fuel problem for the past few years. Major attention has been given to processing plants designed to handle a *variety* of fuels from a *number* of reactors. Most studies indicate that to achieve low unit costs, such plants require a substantial capital investment and a plant capacity well in excess of the present commercial market.

"Package" Deal

An alternative approach to the processing of spent radioactive fuels that might be suitable to the market conditions of the next few years was proposed by Charles G. Manly of AEC at the Reactor Fuel Processing Symposium in New York, October, 1957. Manly suggested a "packaged" reprocessing plant designed to recover radioisotopes, in addition to uranium and plutonium, as the best solution to the problem of low cost processing. Each plant would be designed to process the reactor fuel used by one reactor "owner" at a particular reactor site.

The economics of this approach are still uncertain because chemical reprocessing has not advanced to a stage where firm cost statements can be made: data are lacking on which chemical plant is best to use, storage of waste solutions, and the size of the market for fission products. However, the possibilities of a packaged plant are attractive as an *initial* step for industry. The potential revenue from the sale of recovered by-products is the major factor that makes it attractive. Also it would permit industry, rather than the Government, to handle the licensing requirements for processing "hot" fuels.

Cost Advantages

Integration of plant and reactor processing at the site of a large reactor offers cost advantages over plants at separate sites, such as sharing of land, utilities, overhead, site improvements, common staffing, laboratories, etc. Such an arrangement could also

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save on the cost or rental of shipping containers and the cost of transporting radioactive fuel elements. The processor could ship clean, "cold" fissionable material at much lower cost. Accountability requirements and process control could be reduced. A single fuel could be processed continuously without the expense and loss of time for cleanout required for processing of different fuels.

There is the probability that, when a sufficient volume of spent fuel is available to keep a large reprocessing plant operating at a reasonable load, unit costs would be lower than those for a small packaged plant. But the main point is to explore ways in which industry can provide for the processing of spent fuel elements in the quantities likely to be available in the next few years *at the lowest cost.*

Revenue from Isotopes

"Operators should not consider reactors merely as sources of heat," contends Manly. The plants also produce millions of curies of radioactivity in fission products which can also be a source of revenue. It is the potential magnitude of such revenue that makes the packaged processing plant worth examining. Revenue may be gained from the "cooling" of spent fuels in an on-site gamma radiation facility prior to processing, or from rentals for use in an off-site facility. For example, the AEC derives $100/yr. per MTR fuel element from such rentals, including the four per cent a e charge.

Reprocessing plants can also be the direct source of revenue from sale of radioisotopes recovered from the gross fission products. It is possible that the market for these isotopes can be greatly expanded. At present, this exansion might possibly be hindered by the inability of the AEC to guarantee larger quantities for sale. These isotopes are now obtainable as the result of processing radioactive fuels, but they require further separation and purification. These additional steps offer the real advantages to be derived from the sale of bulk quantities of radioisotopes. The additional capital outlay required is only incremental to the original cost of the reprocessing plant. This should be low enough to be attractive for at least some isotopes. For instance, the extraction and sale of long-lived cesium and strontium isotopes from processing plant waste could aid in simplifying the storage and disposal problem.

Lacking specific engineering design data, certain assumptions must be made: the plant would be designed as an integral part of a nuclear power

(*Continued on page* 124)

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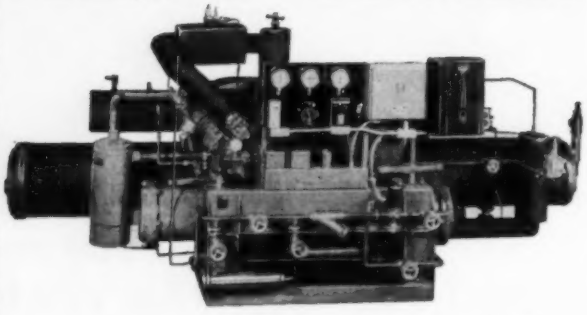

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REPROCESSING . . .

(*Continued from page* 123)

station, would handle a single type of fuel. Minimum capacity would be sufficient for an average 1.3% * enrichment type fuel at 13,500 kg./yr., or 1.9% † at 16,200 kg./yr. Operating cost of such an integrated on-site plant (including a hypothetical krypton-85 recovery at about $15/curie) should not exceed $400,000/yr.

Feasibility

Although the AEC has experience in fuel reprocessing technology and fission-product recovery, they know little of the design problems inherent in this theoretical small plant. The small throughputs of reactor fuels from a single power station require use of the simplest, lowest-cost reprocessing plants. Many variations in the design of a packaged plant seem possible. It might only process as far as the first decontamination step, or it might go further, depending upon the fuel fabricator's use of material. It might merely make a gross separation of fissionable material from fission products to produce uniform feed for a central processing plant.

The idea of a packaged processing plant using by-products might make the reprocessing of radioactive fuels more attractive to industry. For special situations reactor owners might also own the reprocessing plant. Chemical plant designers can expect at least a limited market for stripped-down packaged reprocessing plants. Every purchaser of a large reactor, private or Government, would be a prospective customer, regardless of geographical location. Expanding chemical companies might consider one or two packaged plants as a part of their development programs.

"This suggestion is not a panacea," concluded Manly. "It applies only to the handling of the fuel business now developing. It is the step industry must take to meet the 1961 market for processing spent nuclear fuel. It seems feasible without a large capital investment. Whether this can be done profitably depends on the ingenuity of chemical plant designers. But one important fact must be considered: *there are only 3 to 4 years remaining until 1961 when spent fuel from domestic reactors must be processed. There is no time to delay in tackling the problem.*"

* Fuel from Dresden plant of Commonwealth Edison.

† Fuel from Rowe plant of Yankee Atomic Electric Company.

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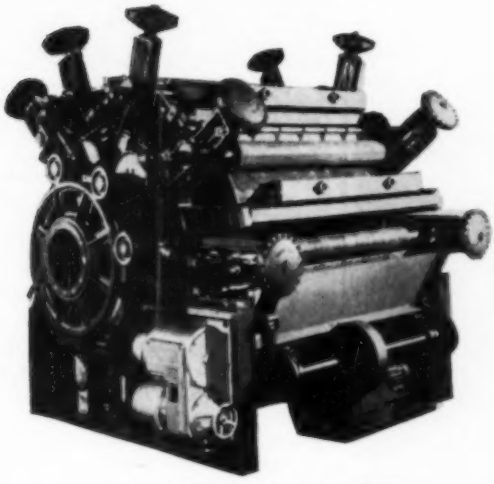

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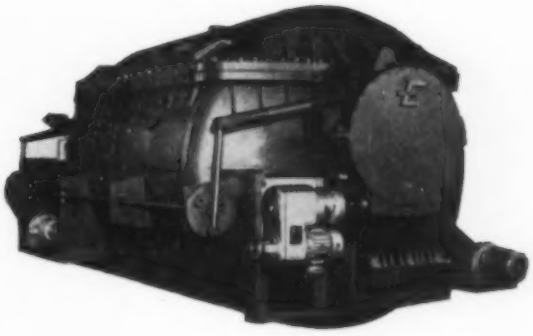
Filters in Soda Ash Process (Uses 3, 4 and 5 press rolls)



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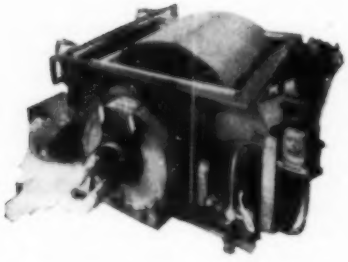
Handles flammable material



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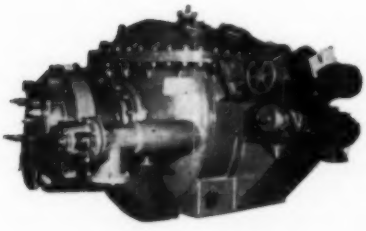

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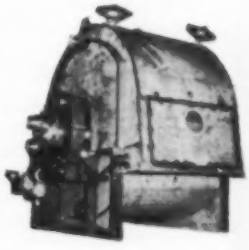

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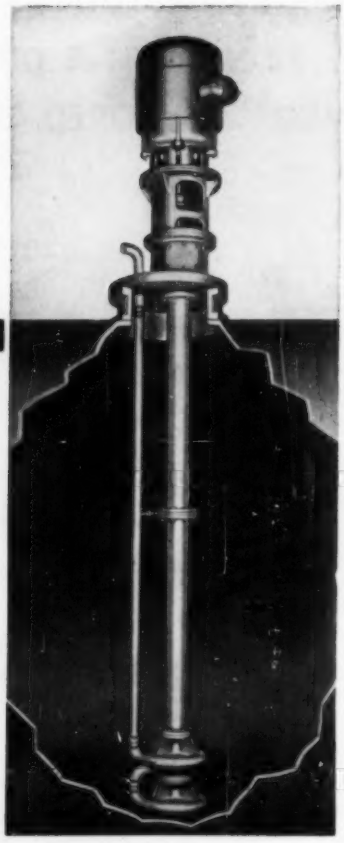
B-296

Lawrence 2-Stage Vertical Pump for Pumping Liquid Chlorine out of Tanks.



PUMPS to handle LIQUID CHLORINE

Pumping liquid chlorine calls for more ingenuity and engineering skill than is available from the average pump manufacturer. Formerly it was pumped pneumatically. This method was attended by a considerable loss of chlorine because the moisture in the air formed hydrochloric acid. A further complication was the corrosive action of the acid vapors.

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NUCLEAR NEWS

The first 10-million-volt tandem accelerator—claimed to be the world's largest Van de Graaff—is in the assembly stage at High Voltage Engineering Corp., Burlington, Mass. The 34-foot long steel pressure vessel shown in photo measures 8 feet in diameter, and covers the voltage-generating assembly of the unit. Tandems are being built by High Voltage for Atomic Energy of Canada, the University of Wisconsin, and Florida State University. Cost of the 35-ton research units is about $1 million each.

The Shippingport, Pa., pressurized water reactor went critical on December 2, 1957. During initial start-up, the reactor operated at a power level of about 25 kilowatts of heat, at full power is expected to produce 60,000 kilowatts of electricity to be fed into the system of the Duquesne Light Co. Design and construction of the nuclear portions of the plant were by Westinghouse Electric, the turbine generator section by Duquesne Light Co., which also contributed $5,000,000 toward the nuclear portion of the facilities. Duquesne Light will also operate the entire plant for the Atomic Energy Commission. □

An entire atomic energy reactor, packed in 26 crates, has been shipped to West Germany for installation in the Institute for Nuclear Research in West Berlin. According to the manufacturers, Atomics International, the solution type, enriched uranium research reactor will be used to train students in production and study of short-lived radioisotopes, radiation effects on materials, and general reactor theory, operation, and maintenance. □

Initial design of a "radically-new" high-temperature, high-performance nuclear power plant will be promoted by a recently-formed group of private industrial and utility companies. To date, the new group, American Nuclear Power Associates, consists of: Burns and Roe, Inc., New York City; Clark Bros. Co., Olean, N.Y.; Griscom-Russell Co., Massillon, Ohio; Rockland Light and Power Co., Nyack, N.Y.; and Raytheon Manufacturing Co., Waltham, Mass. The proposed power plant will be based on Raytheon's liquid metal fuel—gas cooled reactor concept. □

OVERSEAS NEWS

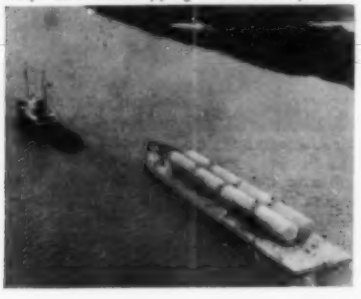
Capacity of the Administration Nacional de Combustibles Alcohol y Portland (ANCAP) refinery at Montevideo, Uruguay, will be more than doubled through a new expansion program which calls for the addition of five new units. The units will be designed and engineered by M. W. Kellogg Co. To be added are: a 28,000 bbl./day atmospheric and 10,000 bbl./day vacuum unit, a 5,000 bbl./day (fresh feed) Orthoflow fluid catalytic cracking unit, a gasoline stabilization and gas recovery unit, and a 4,500 bbl./day gasoline treating unit. □

Guar gum processing has started at the Karachi, Pakistan, plant of Habib-General Ltd., a Pakistan company 60 per cent owned by General Mills, Inc., which has operated a large guar gum plant at Kenedy, Texas, since 1952. The Karachi plant, which will double General Mills' output of guar gum, will serve world markets which were formerly unreachable because of unfavorable dollar exchange rates and foreign import restrictions. □

Studies looking to the establishment of a nitrogenous fertilizer plant in the Lower Congo will be carried forward by a syndicate including three of the most important Belgian chemical companies. Making up the "Syndicat Azotinga" are Societé Belge de l'Azote et des Produits Chimiques du Marly, Societé Carbochimique, and l'Union Chimique Belge. □

A new Universal Oil Products-designed fluid catalytic cracking unit is on stream at Caltex S.A.F., French affiliate of California Texas Oil. The new unit, which processes Middle East crudes, is rated at 5,150 b/sd with coke burning capacity of 4,500 lb./hr. □

American-made butadiene is enroute by barge from Port Neches, Texas, to Ravenna, Italy. The dramatic experiment in long distance barge transportation is being made by Goodrich-Gulf Chemicals. Destination is a synthetic rubber plant operated in Ravenna by ANIC of Italy. Estimated shipping time is 35 days.



Twin Strainer with special back-flushing feature

While flow goes through this compartment
This one is closed for cleaning. Back-flushing water enters at side, drains at bottom.

Elliott Twin Strainers are built in two types. With Type A, one strainer basket is removed and dumped, while liquid flows through the other basket. Type A strainers are also built with a back-flushing feature, whereby the closed-off compartment is cleaned by reversing the liquid flow. Flushing and draining connections permit liquid to enter side of compartment, flow through basket and drain at bottom. Type V, with large-size baskets, is designed primarily for handling oil and viscous liquids.

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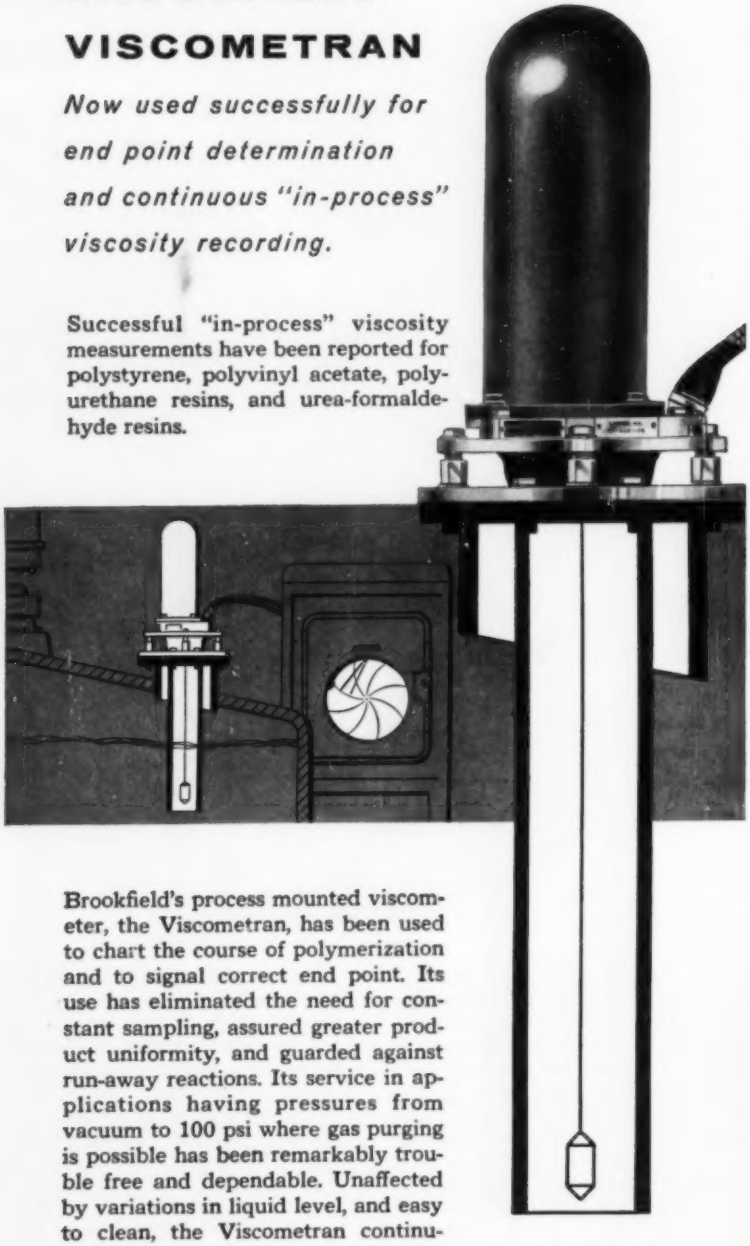

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news from local sections

U.S. PETROLEUM RESERVE PRODUCTION RATIO DECLINES

"Unless the U.S. petroleum industry discovers 3.6 billion barrels of new oil sources each year, as the result of greatly expanded drilling programs, United States oil production will not reach the predicted demand level of 14.3 million barrels per day by 1966," said petroleum economist John G. Winger at the **Philadelphia-Wilmington Section's** (*André W. Pollock*) November meeting. He pointed out that the country-wide demand for oil will grow at the rate of 5 per cent a year in the ten-year period from 1956 to 1966 to the 14.3 million b/d level.

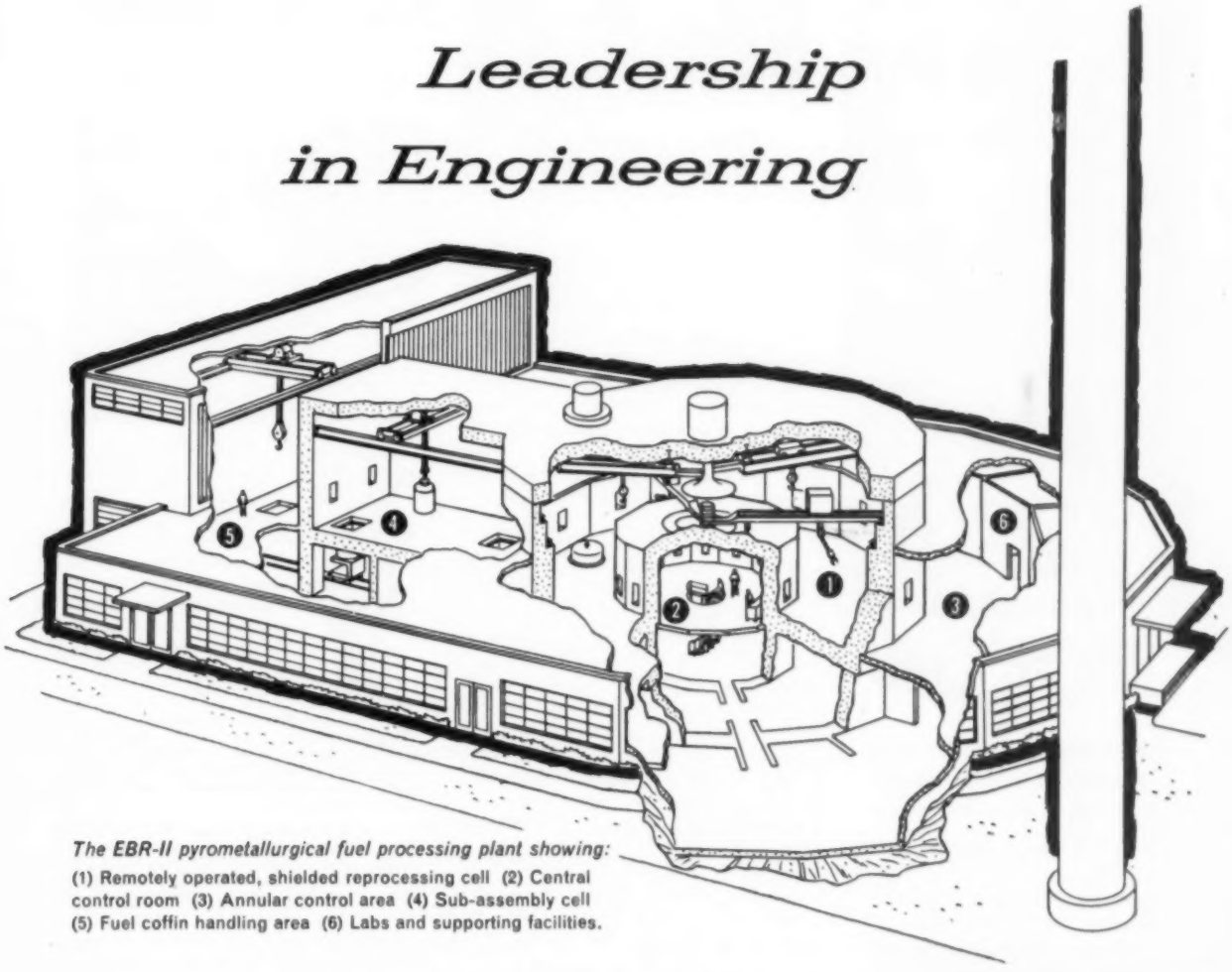
Winger explained that these figures were based on a detailed study of the total energy requirements associated with population and economic growth. He concludes that the U.S. will consume 61 quadrillion B.t.u. in 1966 (an increase of 45 per cent over the 1956 need for 42 quadrillion); petroleum is expected to supply about half of this.

Crude oil reserves in the Free World are ample in respect to anticipated demand growth, but are unevenly distributed with respect to consumption. United States needs 57 per cent of the world demand, but supplies only 15 per cent of the reserves; it has only a small reserve producing capacity and further growth is dependent on the rate of new discovery. To accomplish an estimated 735,000 necessary wells

(*Continued on page* 130)

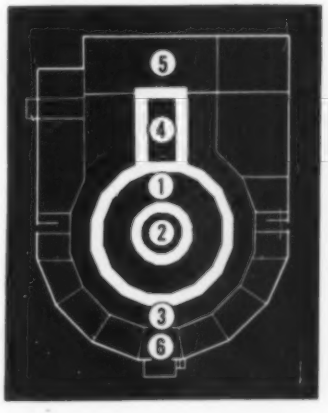
Special award for the best paper presented at the Baltimore National A.I.Ch.E. meeting was given to R. M. Schatz of Esso Research for his paper on "Hydrogenation of Carbon Monoxide on a Steel Catalyst" by S. L. Tyler, past Secretary of A.I.Ch.E., at a recent New Jersey Section meeting. Left to right above are: Tyler, J. W. Axelson, section chairman, and Schatz.

Leadership in Engineering



The EBR-II pyrometallurgical fuel processing plant showing:
(1) Remotely operated, shielded reprocessing cell (2) Central control room (3) Annular control area (4) Sub-assembly cell (5) Fuel coffin handling area (6) Labs and supporting facilities.

A unique pyrometallurgical reprocessing system which keeps the fissionable material in the metallic state will be integrated into Argonne's Experimental Breeder Reactor II Plant in Idaho. This system will be operated and maintained entirely by remote handling equipment. Here the highly radioactive spent fuel will be cleansed of the bulk of the fission products, reenriched, and fabricated into new fuel elements for return to the reactor. In the past, reprocessing of nuclear fuels has been separated from the reactor plant design and involved many chemical conversions. The design and development of this new fuel cycle is a joint effort of the Chemical Engineering, Metallurgy, Reactor Engineering, and Remote Control Engineering Divisions.



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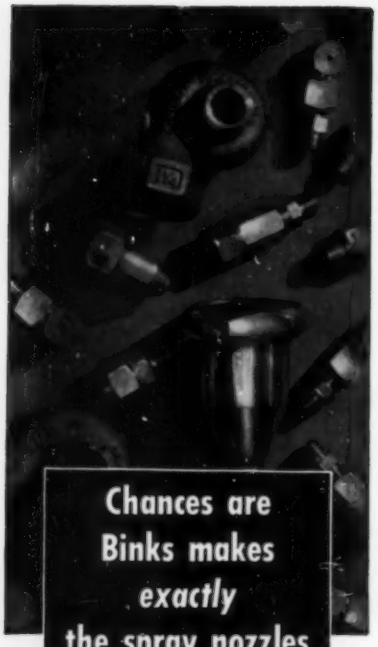

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news from local sections

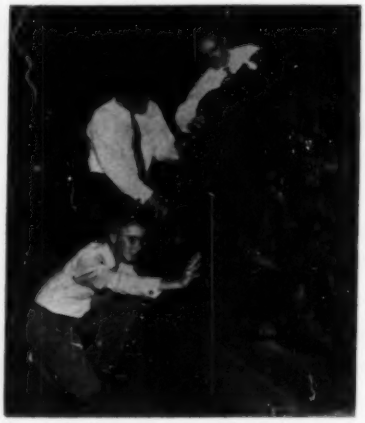
(*Continued from page* 128)

in the next decade, sufficient funds must be provided from capital formation under a favorable tax and regulatory climate, Winger emphasized.

Domestic industry has found an average of 3.1 billion barrels/yr. in the post-war decade but, with production climbing rapidly, the reserve-to-production ratio has declined. We must *find* 1.5 barrels for every barrel *produced* to provide an adequate inventory of reserves for growing demand. *The U.S. has failed to do this for the past five years.* To meet the increased production forecast (that is, from 7.2 million b/d in 1956 to 9.5 million b/d in 1966) the petroleum industry must discover an average 3.6 billion barrels/yr.—15 per cent over the post-war rate.

Because reserves are large relative to production, Free Foreign output is capable of expansion (in most areas) at a rate much faster than in U.S. The Middle East, Venezuela, and Canada will contribute to the increased Free World production. Since these areas are at an earlier stage of development, their energy requirements are expected to increase more rapidly than those of the United States. Their expected energy needs will require about 14.2 million b/d by 1966; and the preponderance must come from

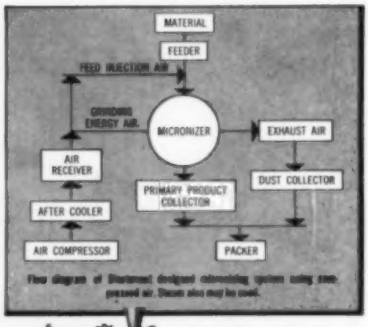
(*Continued on next page*)



Three of the more than 70 students and teachers from the Belchertown, Massachusetts, High School study the 15½-ton Wilamette meteorite at the American Museum-Hayden Planetarium in New York City. The boys were part of a student group from the Springfield-Pittsfield area brought to N.Y. by the Western Massachusetts Section of A.I.Ch.E. to attend a special presentation "Chemistry on a Cosmic Scale" in September. *(Photo courtesy American Museum-Hayden Planetarium.).*

Need ½ to 44 Microns?

Sturtevant Micronizers* Make 325 Mesh Obsolete



Flow diagram of Sturtevant designed micronizing system using compressed air. Steam also may be used.

One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from ½ to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

Production Model (15 in. chamber)

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Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (½ to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

Engineered for Special Needs

A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

Can Test or Contract Micronizing Help You?

Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 135 Clayton St., Boston, Mass.

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FIRST OF ITS KIND

CHEMICAL AND PETROLEUM ENGINEERING EXHIBITION

An outstanding development in British industry in the last twenty years has been the expansion of the Petroleum refining and Chemical Industries. The Chemical and Petroleum Engineering Exhibition—the first of its kind—will present dramatic evidence of the tremendous achievements that have been made.

At Stand after Stand, contractors, designers and specialists in every branch of British chemical and petroleum engineering will have something to show of vital interest.

The Exhibition will also include a conference on "The Organisation of Chemical Engineering Projects" arranged by The Institution of Chemical Engineers and The Institute of Petroleum; and films will show how the Chemical Plant and Petroleum Equipment Industries have helped in the development of their consumer industries.

A visit to this Exhibition is a MUST to all concerned in chemical and petroleum projects and to everyone whose industry is in any way influenced by such projects.

JUNE 18-28 1958
OLYMPIA
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AN EVENT TO REMEMBER

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At the speaker's table during the Rochester Section's October meeting, where J. A. Nicol described pneumatic conveying of powdered or granular bulk material, are (left to right): Earl Costich, Earl Hogan, Nicols, and Bernie Johnson, section vice-chairman.

oil because natural gas is not as readily available as in this country, and because it is difficult to expand solid fuel supplies in these areas.

NEW SECTIONS START OFF ON RIGHT FOOT

"Military requirements and development work by the rocket industry, in their search for a smokeless propellant with improved performance, have led to a greatly increased demand for ammonium perchlorate." This was the explanation for the growing interest in methods of manufacturing this material given by David R. Stern at the November meeting of the new **Mojave Desert Section** (*William P. Koontz*) of A.I.Ch.E. In his talk, Stern described an existing large-scale modern plant for the production of ammonium perchlorate, including details of the process, instrumentation, and operating variables, also mentioned some of the newer developments in the perchlorate industry. (See *CEP*, September 1957, p. 428.)

"The chemical industry is second only to coal mining in West Virginia," said Donald Crislip of the State Industrial and Publicity Commission in

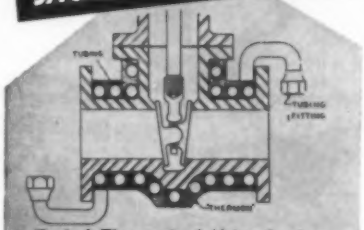
(*Continued on page* 136)

Pictured above are officers of new Northern West Virginia Section who were installed in December. Seated, left to right: F. S. Hirsekorn, past chairman (Frontier Chemical Co.); L. E. Liljequist, chairman (UCC Silicones Division). Standing, left to right: D. W. Barber, chairman-elect (DuPont Co.); P. J. Baker, treasurer (Mobay Chemical Co.); R. J. O'Conners, executive committee (UCC Silicones Division); O. E. Berry, executive committee (Corning Glass Works); and W. C. Ortt, secretary (UCC Silicones Division).

Thermon

The Revolutionary New Solid
HEAT TRANSFER MEDIUM

SAVINGS UP TO 75% over JACKETED EQUIPMENT



Typical Thermonized Valve Section

Thermon, the product, and Thermonizing, the process, represent a revolutionary new concept in the science of external heat application. Thermon is a non-metallic plastic compound with highly efficient heat transfer properties, and is easily applied in a viscous paste form over either steam traced or thermal electric systems. It completely surrounds the tracer tubing and conducts heat to the entire surface to be heated.

Definite Advantages of Thermonizing are:

1. LOW COST—save up to 75% over equal jacketed equipment.
2. EXCELLENT HEAT TRANSFER—Exceeds steam traced equipment approximately 1100% and very closely approaches jacketed equipment.
3. DEPENDABILITY—no hot or cold spots.
4. WIDE TEMPERATURE RANGE—used for sub-zero cooling or heating to 750°F.
5. NO JACKET PLUGGAGES OR PRODUCT CONTAMINATION—in case of equipment failure, Thermon separates product from heating medium.
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8. RAPID DELIVERY—use of standard equipment permits minimum delivery time.

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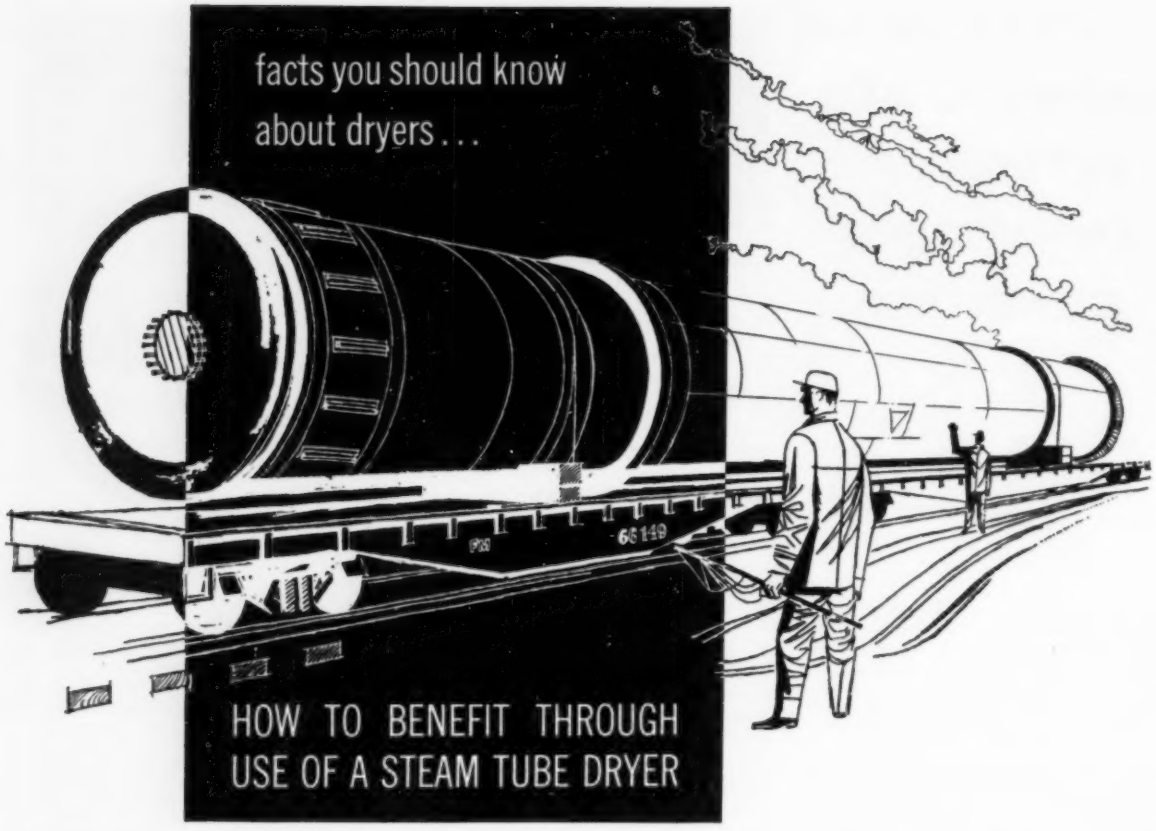

For over 55 years, Louisville Dryers have been solving industry's drying problems and effecting marked economies. This experience can often be applied to provide unusual benefits in specific cases, possibly yours, for example . . .

Q. *Since avoiding dust loss and contamination by furnace gases indicates the choice of an indirect heat rotary dryer for my material, what type of indirect dryer would you recommend?*

A. Unless there are abnormal conditions, *we would recommend a steam tube dryer*, especially if the material is heat sensitive.

Q. What advantages does the steam tube dryer offer *in comparison with indirect fire types?*

A. There are many advantages. One is ease of operation and low maintenance costs due to the definite moderate temperature (established by steam pressure) imposed on both the material being dried and on the dryer itself. Another advantage is that there is no furnace refractory maintenance. Still another advantage is quick "warm up" and "cool off". In many cases where the drying operation is intermittent, there is no need to shut off the steam supply or stop rotation when the wet material feed is interrupted since steam is condensed in quantity only when wet material is fed.

Q. *Isn't steam supposed to be an expensive drying medium?*

A. That depends on how the steam is used. It is true that a low overall efficiency results (often as low as 25%) when steam is used to heat air for low temperature drying. However, the Louisville Steam Tube Dryer normally utilizes 85% or more of the available heat in the steam. By combining this with a reasonable minimum efficiency of 80% in modern small steam generators (and higher in large boiler plants), you get an overall efficiency close to 70%. This compares with indirect fire dryers which develop an efficiency seldom higher than 50% and generally less.

Q. *Does material insulate the tubes by sticking to them or by clogging the spaces between tubes?*

A. Very few materials have this tendency to any serious extent and most of these, when properly conditioned before feeding, handle without difficulty. For the balance, no dryer using heated surfaces for heating the material is a proper application.

Q. *How can I be sure a Steam Tube Dryer will handle and dry my material satisfactorily?*

A. The General American dryer pilot plant is at your service. No charge for routine tests and demonstrations. No obligation, either. Write for test date.

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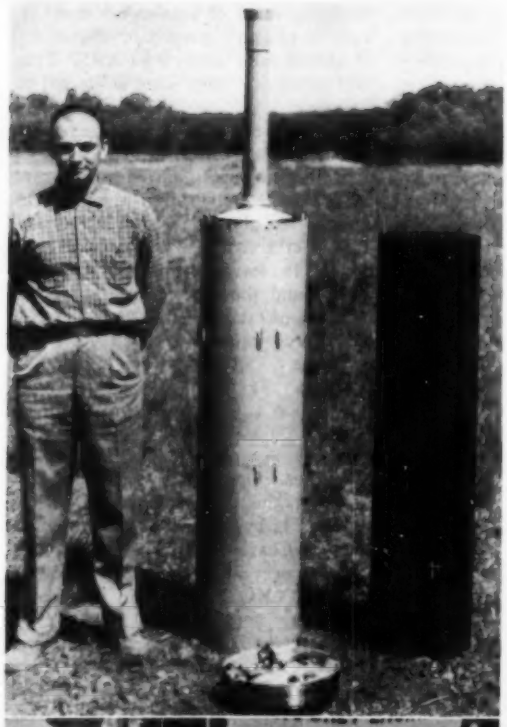
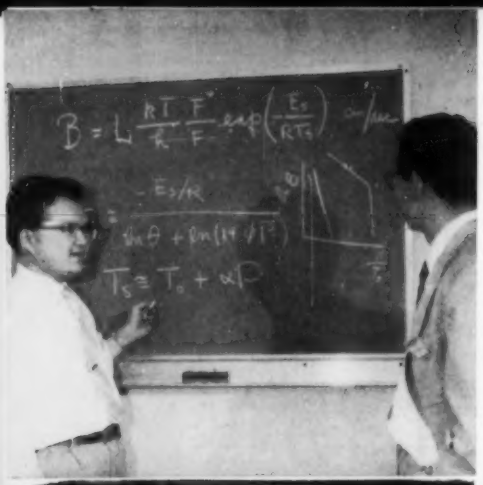
CHEMICAL ENGINEERS AND MISSILES



The scene above shows a group of nearly one hundred chemical engineers viewing test firings of some of our mightiest rocket engines for missiles at Rocketdyne's Santa Susana test facility just north of Los Angeles. At the left is a young chemical engineer typical (age, education, experience, etc.) of many who are today manning our missile development program, as visited by *CEP* Camera in a tour of major missile installations. He is standing by a solid propellant rocket engine, the propellant charge being the black object on the right. This is a large engine for its type, and is capable of thrusting a missile hundreds of miles into space. Being simple, it offers many obvious advantages over the liquid type of engine shown below in cutaway model—if it can be made to do the same job as well and as safely. The liquid engine is of the kind to power the first stage of the Vanguard satellite. It will burn kerosene with LOX; thus the complex piping, valving, the turbine-driven pumps, etc. The major large missiles of common public interest today are liquid powered, using engines resembling this one in principle. Many believe that in the future, large ballistic missiles may be solid-propellant powered. All agree that ultimately, nuclear power will be used. The solid propellant charge is within itself deceptively simple. To be contained within the thin, light shell standing by the young man, the charge must burn steadily and long. A complex of geometric design factors, internal inhibitors, coating inhibitors, heterogeneous versus homogeneous oxidizer-fuel mixture relationships, were all resolved in the early art of making fairly small solid propellant rocket engines. Now, medium-scale realization is being left behind and the drive is toward a workable larger-scale art. At the same time, there is a growing science aimed at complete design predictability. One might well ask, just how large a solid-fueled rocket engine may we expect to make, and have work? No one interviewed could say, but a committee working on the national level has been functioning for the purpose of coming up with an answer.

On the following pages are additional pictures from *CEP*'s missile tour.



On the preceding page, the man is Turner Ivey, a chemical engineer who is assistant production manager for Atlantic Research.

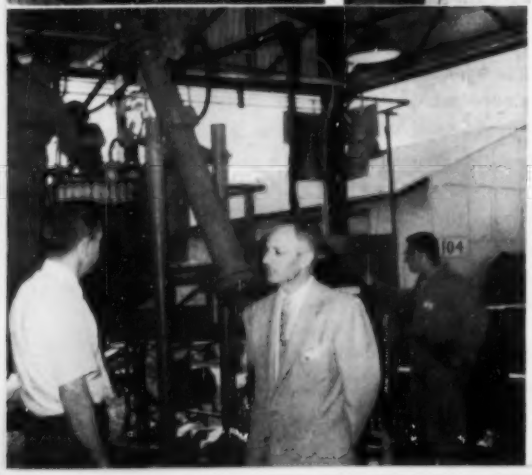
FUNDAMENTALS

The art of rocketry is slowly being displaced by science. Increased sizes of missiles, longer range requirements, heavier payloads of valuable controls —all are factors creating a need for higher certainty factors. In astronautics, scientific-based designs will be essential. Among the fields being studied by the scientists are: ignition (a liquid rocket can blow apart if a few milliseconds delay is experienced), flame stability, free radical formation with controlled recombination, burning of solid composite propellants, and a number of others. The matter of how solid propellants burn is of maximum concern to the two scientists shown at the left. In the upper picture is George Moe of Aerojet. Moe is an exponent of the new technique of predicting burning rates by measuring separately the decomposition temperatures (in linear pyrolysis) of oxidizer and fuel which in a propellant decompose at similar rates. By making such studies on ammonium nitrate (a common oxidizer) Moe found it to have an activation energy of about 7 kilocaleries/mole, whereas it has been generally reported at about 40. This, according to Moe, "may be of importance with regard to other uses for this compound." Moe is active in the field of free radicals, believes their future is closely related to practical harnessing of nuclear power for rockets. "The idea," explains Moe, "is to take advantage of the heat of recombination of the free radicals, which is high. If we could get hydrogen atoms dissolved in liquid hydrogen, and could cause these atoms to recombine—heating and volatilizing the liquid hydrogen to expand through a nozzle (but not burned)—we would get a surprisingly high thrust."

Another modern pioneer in solid propellant burning is Ray Friedman, a PhD ('48) chemical engineer at Atlantic Research (ARC), where he also specializes in catalyst effects. Recently, he has studied the mechanism of deflagration of ammonium perchlorate, a primary propellant ingredient of considerable interest to ARC. This will deflagrate only when subjected to pressures of from 300 to 4,000 lb./sq.in., for reasons not yet understood. Friedman's experiments entailed pressing the material into strands and studying the deflagration in equipment set-ups like the one shown in the picture. Certain trace materials have been found to have a marked catalytic effect, and the rate-controlling factor now seems established to be in the oxidizer decomposition mechanism.

PILOT PLANT

In the solid propellants field, the pilot plant is the means for making experimental lots of fuel-oxidizer combinations. One of the techniques for forming the cylinders of rubber-like product is by extrusion. In the upper picture Charles Havlik, left, a chemical engineer at Naval Ordnance Test Station (NOTS) and in charge of pilot-scale formulations, is holding a compressive screw, while his chemical engineer assistant, H. R. Richards, looks on. The pre-pilot-scale formulation at NOTS is done under the direction of the lady chemical engineer at the right, Mrs. Mary M. Williams (who has two years of graduate work on distillation to her credit). At Aerojet, the pilot plant shown (lower left) is used for exotic fuels, with M. H. Gold, assistant manager of the Chemical Division (where most of the chemical engineers are) shown in right foreground. Solid propellants are also cast, and on the right the outdoor removal of the core from a mold is shown taking place while chemical engineer DeWitt Myatt, manager of development for ARC and well known for his prominent activities in A.I.Ch.E., looks on.



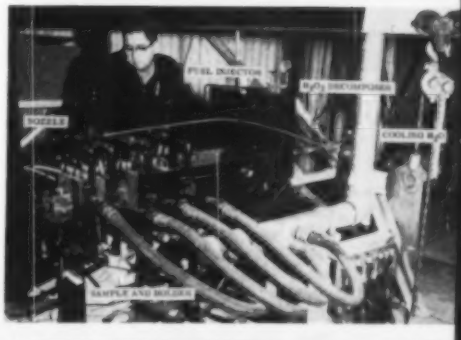
Credit is due to Randy Sheeline, Rocketdyne, for suggesting and arranging visits, and to Mrs. Fay Couch for the NOTS photos.

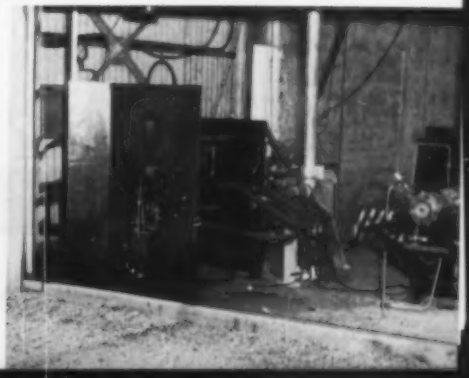
MANAGEMENT

Of the many technologists resolving management problems of the missile program, two chemical engineers stand out in their almost opposite areas of accomplishment. Shown above is Tom Dixon, chief engineer of Rocketdyne. "Boss" over some 2,000 engineers (175 chemical engineers), Dixon likes the adaptability of the chemical engineer, but can't get enough with the desired training in fundamentals, so he literally sends many that he acquires to school. Dixon says: "I need men around me who can contribute to progress in our basic developments. In looking to our professional future, it should seem clear that to do the job of pushing back our limits of knowledge, it takes a lot of training." The man in the dark suit in the center of a management conference group is Arch Scurlock, president of Atlantic Research, a chemical engineer-scientist who did what many dream of doing—he started his own business. In 1949, with ideas worthy of defense support and a minimum of capital, he drew together a nucleus of professional associates that by 1951 had grown to 35. Entrepreneur Scurlock's firm is emphasizing development of a new type of solid propellant, "Arcite." Not shown but interviewed were two other missile managers who represent still other types of contributions. Wm. B. McLean, technical director of NOTS (China Lake) likens part of his career to that of a university administrator. He is devoted to the training of ordnance specialists, has set up and operates both an extension arrangement with UCLA (for fundamentals) and an internal school for classified specialized subjects. Frank Goddard, associate director of JPL, also in charge of Aerodynamics and Propellants, pursues another tack: he endeavors to bring about the most rapid development of coalescence between staff chemical engineers and workers in fluid mechanics.

TEST

Of prime importance to the rocket engine development field is the test facility. As burning cycles are of but short duration—matters of seconds—elaborate data collection, recording, and analysis provisions are required. Shown clockwise, beginning at upper right, chemical engineers touring Rocketdyne are examining one of the several process control centers, each serving the huge test stands on which the largest of our liquid propellant engines are mounted and static test-fired until meeting specification. Next are shown two views of one of the small liquid engine test stands at Army Ballistic Missile Agency. It is in connection with such equipment that many chemical engineers are employed at ABMA. On it, studies of fluid flow, combustion, mechanical design, and variation in fuels and oxidizers are evaluated. Next is shown a wired TV receiver at ABMA. Now a commonly used device at missile establishments, it was seen at ABMA in both black and white and color installations. A larger static test unit is shown at Aerojet's Azusa facility. It is being inspected by Don L. Armstrong (right), manager of the Chemical Division, major employer of chemical engineers within the firm. Eli Mishuck, who directs much of the fundamental research at Aerojet, looks on. As used, the setting up of recorder charts, their removal, cataloging, interpreting, and analysis following the short-duration test firings is laborious and time consuming. Now, data processing systems are being installed, in which the sensing devices are being direct-connected to digitalizing units, to automatic printers, and to computers, to give the experimentors results on the tests in minutes instead of days. By far the most exotic of the equipment installations used in rocketry, the test units will doubtless receive the latest in what is available equipmentwise.





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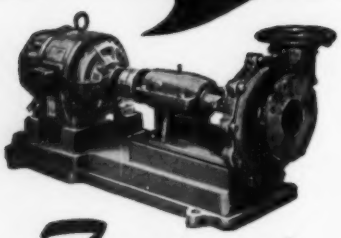

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Write for Bulletin No. 107

FREDERICK PUMPS

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news from local sections

(*Continued from page* 131)

his description of the great chemical expansion in the Ohio Valley at the installation meeting of the new **Northern West Virginia Section** (*L. E. Liljequist*) officers. (See photo, p. 131.)

Another new section, **Syracuse** (*Irwin B. Margiloff*), in October had Norman W. Rosenberg, Research Director of Ionics, Inc., describe "Ion Exchange Membranes in Industrial Solutions," the theory of membranes and examples of their applications, such as off-shore radar stations, and the oil-rich but waterless Middle East. In November they heard Charles F. Moesel speak on "Nuclear Power Reactor Development."

Also Meeting

A big blow of Texas magnitude terminated the **Sabine Area Section's** November 7 meeting. A tornado (just two blocks away) adjourned the meeting after Herman Ulrich had delivered a talk on "Cooling With Air." Earlier in the evening Thomas W. Bell, a senior Chem E. student at Lamar Tech, was awarded $250 as the first recipient of what promises to be an annual award to a worthy student to complete his education. (*A. A. Butler*)

Rocky Mountain Section (*F. H. Poettmann*) heard L. C. Gibbons give a talk on fuels and lubricants for aircraft and gas turbine engines at its September meeting. . . **Baton Rouge Section** (*M. M. Koenecke*) discussed recent studies in miscible phase displacement under the leadership of D. Von Rosenberg at its September meeting, and heard the famous C. F. (Boss) Kettering at its October meeting. . . **Coastal Bend (Tex.) Section** (*R. C. Brandquist*) took up the alternate processes for the production of oxygen, and speaker J. E. Nachod, Jr., Air Products, pointed out the best methods for various types of requirements. . . **Boston Section** (*R. L. Wentworth*) took a long tour through the new research and development facilities of High Voltage Engineering Co. at Burlington, Mass., and heard about the potential for radiation processing in industry. . . **Ohio Valley Section** (*G. W. Claybaugh*) heard about the problems and potential of chemical engineering in the Mojave Desert. Main subject was the advances in dealing with potash, borax, lithium, soda ash, and salt cake from natural brines. Speaker was J. H. Koffolt.

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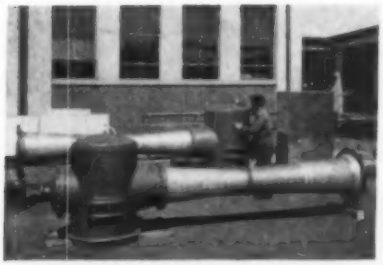
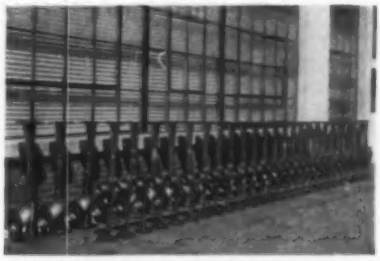
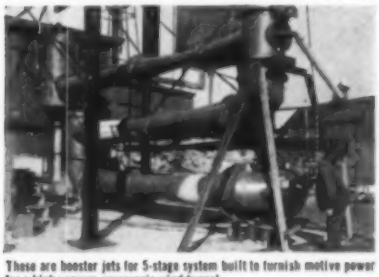


Large steam jet boosters for chemical processing. Stainless steel construction affords better internal and external corrosion resistance lighter weight.



Stainless steel thermo-syphons, used in ordnance plant to heat a corrosive liquid to its boiling point and keep it circulating.



These are booster jets for 5-stage system built to furnish motive power for a high vacuum supersonic wind tunnel.

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RING OUT THE OLD, RING IN THE NEW

George E. Holbrook of Dupont (right) new president of A.I. Ch.E., receives the congratulations of J. Henry Rushton (center), outgoing president. At left is Donald L. Katz of the Univ. of Michigan, new vice-president. Occasion is the Awards Banquet at A.I.Ch.E.'s recent Chicago Annual Meeting.

New technical staff member of S. B. Penick & Co. is **John H. MacDonald,** former plant manager of Nepera Chemical Company's Harriman, N. Y. plant.

Leader of the newly-created industrial fiber group in the melt spinning section of Chemstrand's Research and Development Division is **Richard D. Meyer.**

Tom R. Ragland, formerly vice-president in charge of chemicals and plastics, has been appointed executive vice-president of Union Carbide International Company. He is succeeded by **James Ware,** who has been manager of production and engineering, chemicals and plastics. **Harry L. Willad** becomes associate technical director of Union Carbide Development Company. **Sylvan J. Cromer** has been appointed vice-president in charge of engineering for Union Carbide Nuclear Company.

New appointments at Monsanto include **Charles D. Malloch,** who joins the engineering department of Monsanto's Inorganic Chemicals Division at St. Louis; **Hilliard L. Williams,** who joins the process design section, engineering department of Monsanto's Organic Chemicals Division at St. Louis; **James M. Douglass** becomes a member of the technical services department of Monsanto's Organic Chemicals Division at the company's Krummich Plant, Monsanto, Ill. **John MacPherson** becomes part of the research department of Monsanto's Plastics Division at Texas City, Texas, and **Joe M. Boyd** and **Thomas R. Winkle** become members of the technical service department.

William E. Hanford, Olin Mathieson Chemical Corp., received an honorary membership in the American Institute of Chemists at a dinner meeting December 12, 1957, at the Hotel Commodore, N. Y. C. Hanford addressed the group on the "Need for Prescience in Organic Chemistry."

(*Continued on page* 140)

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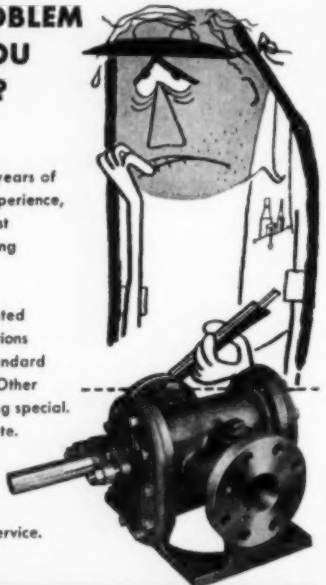

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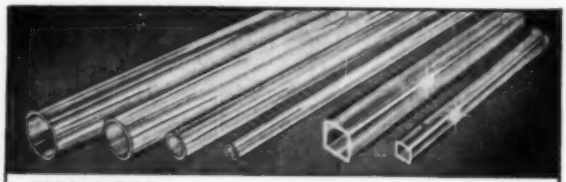

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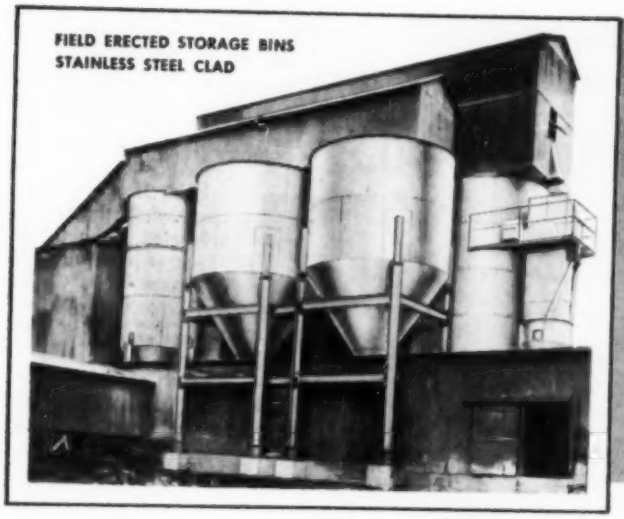

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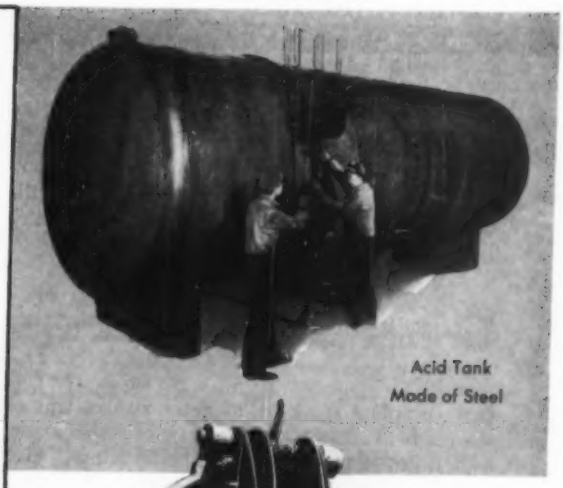

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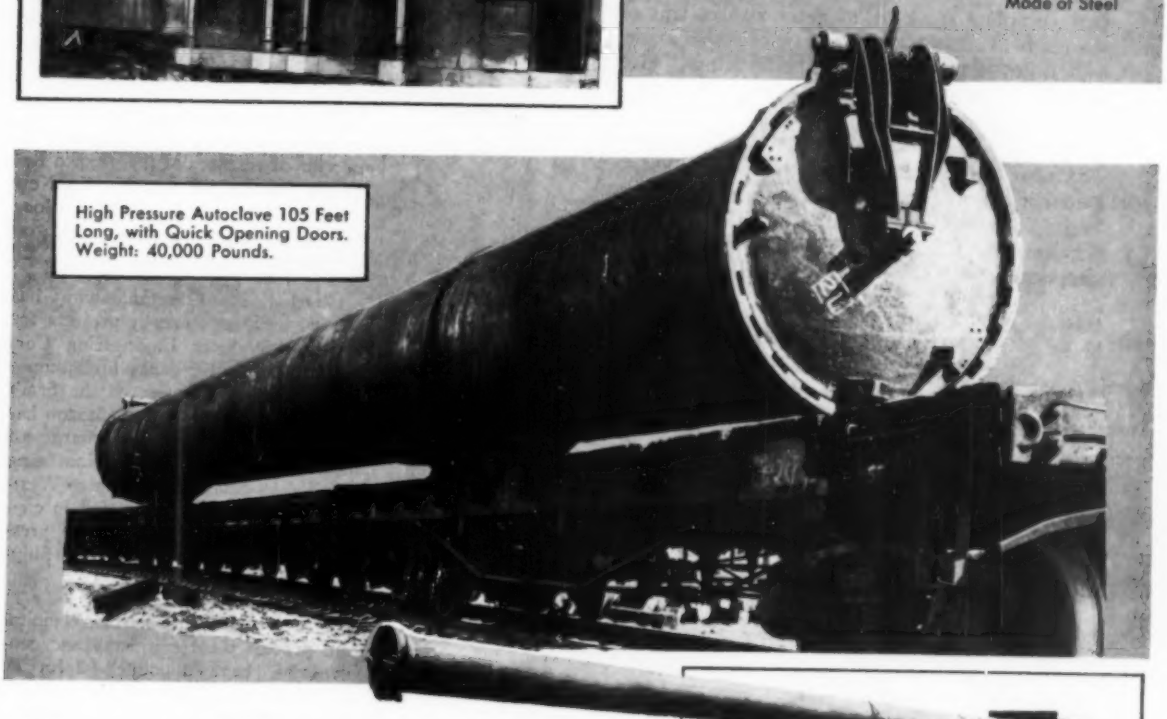

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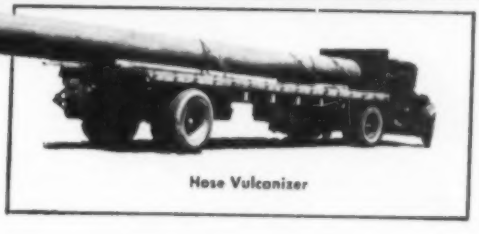

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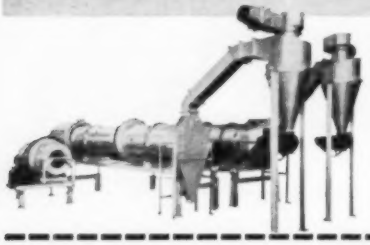

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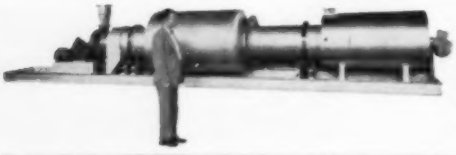

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people
(management & technology)

(*Continued from page* 138)

Mack

Baker Perkins, Inc., Saginaw, Michigan, has appointed **Kenneth A. Mack** as vice-president in charge of its Chemical Machinery Division.

Walter J. Porter, Jr., has been appointed assistant head of catalytic research and development at the Esso Research Laboratories, Baton Rouge, La.

Former assistant director **Patrick J. Keating, Jr.,** has been promoted to director of research at the Texaco Research Center, Beacon, N. Y. New assignment for **A. R. Vander Ploeg** will be assistant to management on the managerial staff at Beacon.

Charles R. Claxton, who has worked on atomic energy projects for Stone & Webster Engineering Corporation since 1954, has been named assistant chief engineer of the firm's nuclear projects division. Claxton has been project engineer in charge of the architect-engineering services being supplied by Stone & Webster to Westinghouse Electric Corporation in connection with the design of the pressurized water reactor project at Shippingport, Pa.

Crawford & Russell, Inc., chemical and process plant engineers and constructors, have appointed **John F. D'Antonio** manager of their Board Processes Consulting Division.

Anderson

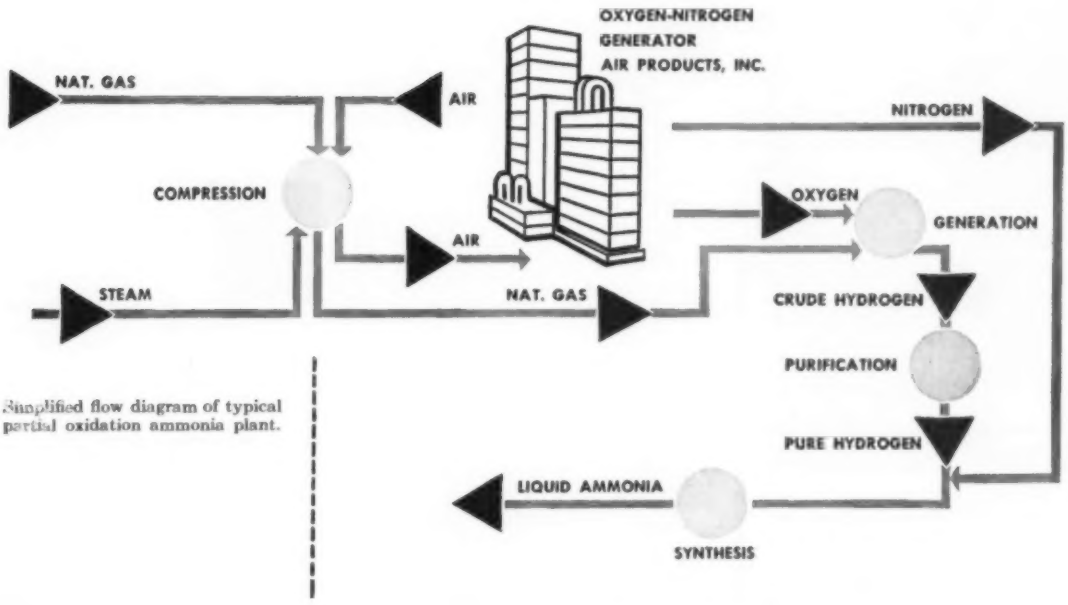
Byron J. Anderson has been named manager of the polyethylene plant which will be built at Houston, Texas, by National Petro-Chemicals Corporation. The new plant is scheduled to start operation late in 1958.

S. J. Wommack has been named assistant general manager of the Nuclear Fuel Division of Olin Mathieson Chemical Corporation.

General Anthony C. McAuliffe, vice-president in charge of engineering and construction of American Cyanamid, has been made a Commander in the French Legion of Honor.

(*Continued on page* 142)

Maximum "On-Stream" Time Lowers Ammonia Cost/Ton



Simplified flow diagram of typical partial oxidation ammonia plant.

... using Air Products Oxygen-Nitrogen Plant and Nitrogen Wash Process

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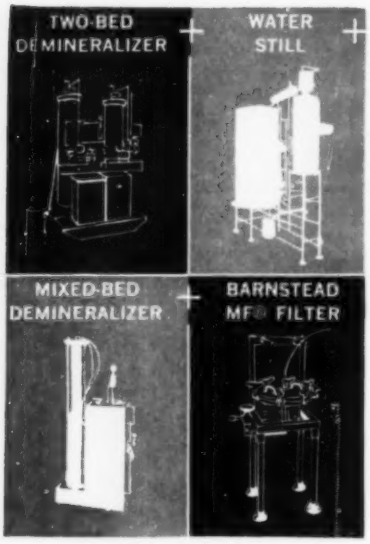

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FIRST IN PURE WATER SINCE 1878

(*Continued from page* 140)

Bowman

John R. Bowman leaves the Mellon Institute in Pittsburgh to go to Northwestern University January 1 as associate dean of engineering and professor of science and engineering.

The Truland Chemical Co., Inc., division of the Trubek Laboratories of East Rutherford, N. J., announces the appointment of **M. F. Lipworth** to be in charge of operations including personnel and maintenance.

Weaver

Joseph C. Weaver, Jr., has been named associate director of the R & D Department of American Oil Co.; Weaver was formerly technical director of the Amoco Chemicals Corporation plant at Brownsville, Texas.

Richard S. Cass and **William H. Crandell** have been admitted to partnership in the Frederick S. Bacon Laboratories, Watertown, Mass. Bacon Laboratories specializes in chemical research and product development.

A top honor student of Case Institute of Technology, **J. Michael Skaates,** has begun graduate studies in chemical engineering at Ohio State University under a $3,000 fellowship awarded him by Battelle Memorial Institute.

Haas

Vice-president of Archer-Daniels-Midland Co., Minneapolis, Minn., **Frank C. Haas,** is retiring from his present position but will continue association with the firm as a consultant. **Burton W. Schroeder** succeeds him.

Robert E. Conary has been named to a new assistant manager post in the research division of the Research and Technical Department of The Texas Company. Conary will be responsible for chemical research activities at the Research and Technical Department in Boston.

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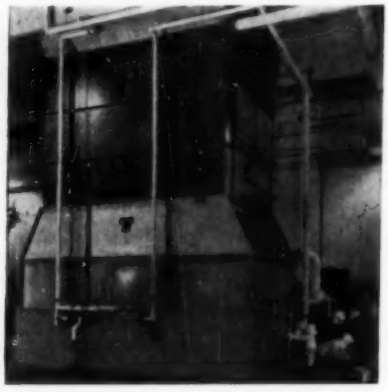

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Patterson

Formation of Chempro, Inc., a Pennsylvania chartered corporation, is announced by **J. A. Patterson** and **Carl Labovitz,** engineers and associate executives in the firm. The new company, with offices in the Plaza Building, Pittsburgh, Pa., is engaged in general engineering and consulting work specializing in chemical processes for industry.

Labovitz

After 15 years as vice-president of Fischer and Porter Co., **Nathaniel Brewer** retires to establish a consulting engineering service, Control Instruments Laboratory, Newtown R-2, Pa. C.I.L. will design control components, systems, and process equipment on a custom basis.

Leaders of industry and education held a recognition dinner to honor **Fred Hoffman Rhodes** at the Plaza Hotel, New York, October 28. Rhodes, who was retired as Professor Emeritus at Cornell University in June 1957, was the founder and first director of the School of Chemical Engineering at Cornell. He held the S. C. Johnson Chair of Chemical Enginering.

Promotions at Foster Grant Co., Inc., Leominster, Mass., chemical and plastics producers, include four new vice-presidents: **Jacob Chatkis,** vice-president and secretary; **Sidney J. Baum,** vice-president in charge of plastics development and production; **Milton W. Bernstein,** vice-president in charge of sales for the Molded Products Division; and **F. Drew Mayfield,** vice-president in charge of the company's monomer plant in Baton Rouge, La.

M. W. Kellogg Co., N. Y., announces the appointment of **C. C. King** as manager of the Process Engineering Department. Other advancements at Kellogg include: **H. C. Pitcher** to the position of construction manager; **Heinz Heinemann** to assist in planning technical coordination and long range research, and **J. L. Patton** as manager of the Chemical Process Division.

King

Patton

(*Continued on page* 144)

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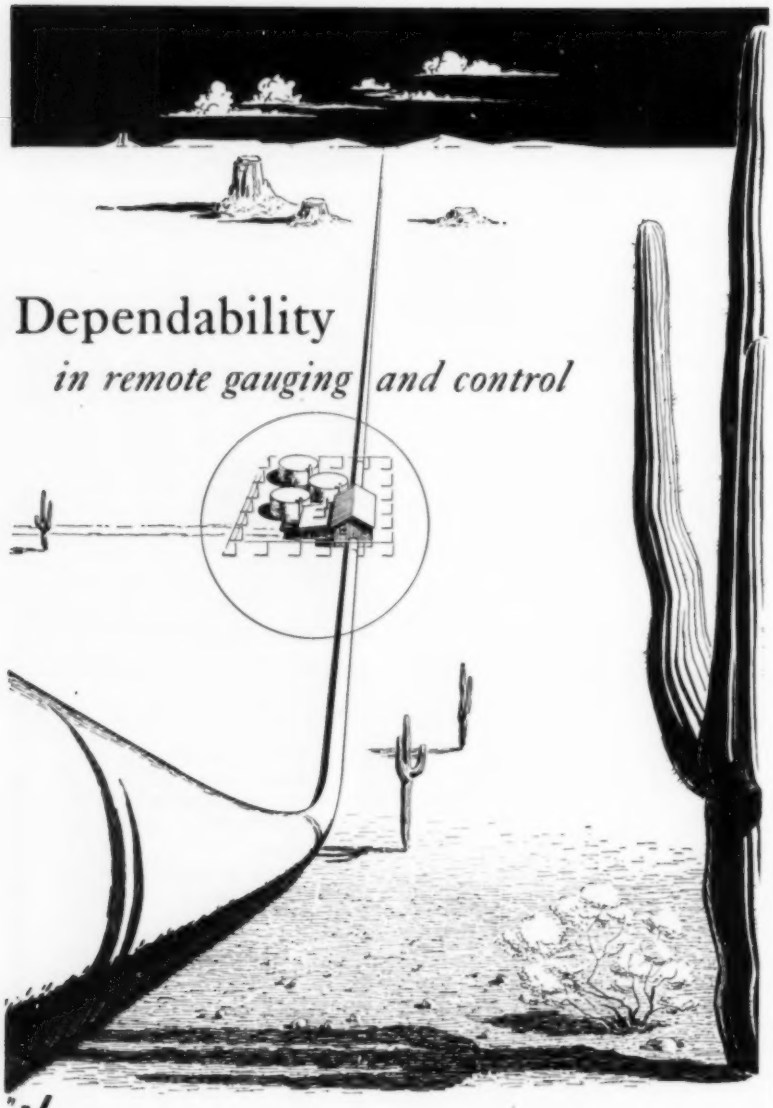

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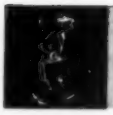

people
(marketing)

(*Continued from page* 143)

Union Carbide picks **John A. Field** for the newly-created position of vice-president of marketing. Field will be in charge of all of Carbide's chemical marketing functions, now being consolidated in an integrated company marketing organization.

Field

Norman P. Phillips has been made manager of sales development for The General Tire & Rubber Company's Chemical Division. He has been engaged in chemical sales work since 1950.

The election of **Norman E. Hathaway** as director and vice-president of marketing for Oronite Chemical Company is announced. Hathaway joined Oronite in San Francisco in 1954.

Hathaway

Arthur S. Nislick has been assigned as a sales representative to Allis-Chalmers' New York district office. Nislick recently completed the Allis-Chalmers training course for graduate engineers.

John T. Castles has been appointed sales manager for the Silicone Products Department of the General Electric Company. He came to G.E.'s silicone operation in 1947.

Fred Royse, sales manager of the Fluor Corporation, Ltd., Houston sales office since 1946, has been promoted to the newly-created post of vice-president, sales, for the Fluor Corporation of Canada, Ltd., the engineering-construction firm's Canadian subsidiary in Toronto.

Royse

Appointment of **G. C. Zwick** as special field representative for The Goodyear Tire & Rubber Company's Chemical Division has been announced by the company. With headquarters in Chicago, Zwick will provide sales and technical service for the high polymer resins, rubbers, and latexes marketed by the Goodyear Chemical Division.

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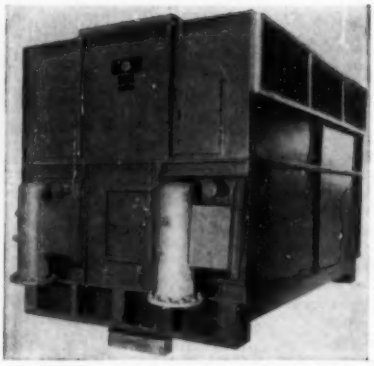

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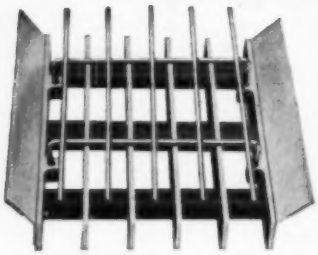

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The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before February 15, 1958, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

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• Davison, Joseph W., *Bartlesville, Okla.*

• Feldman, James A., *Bartlesville, Okla.*

• Gillespie, Daniel C., *Glenbrook, Conn.* Gillett, Will H., *Dallas, Tex.*

• Heyward, Nathaniel J., *Edgewood, Md.* Hill, Russell G., *Bronxville, N. Y.* Hinze, Robert B., *Chatsworth, Calif.* Hudson, William S., *Houston, Tex.*

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• Raimond, William A., *New York, N. Y.* Randall, B. R., *Houston, Tex.* Ross, E. Albert, *Cincinnati, Ohio.* Russell, Barrett B., *Houston, Tex.*

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• Whelan, John N., *Lincroft, N. J.*

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• Di Liddo, Bart A., *Cleveland, Ohio.* Donahue, George M., *New Castle, Del.* Dunah, Richard E., *El Cerrito, Calif.*

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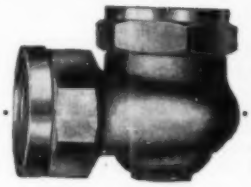

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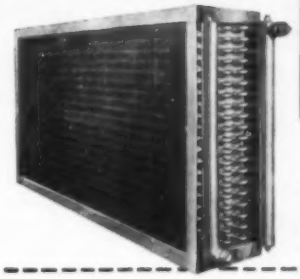

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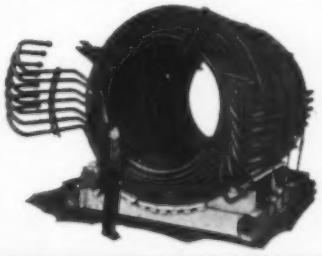

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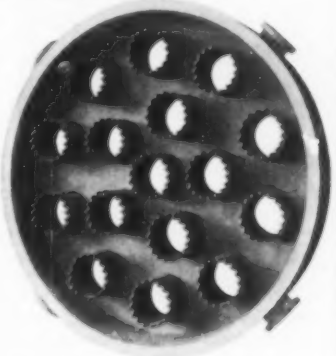

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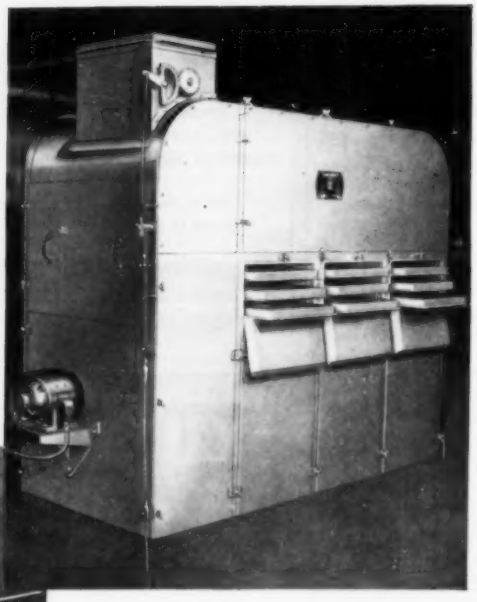

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• Gerhard, James R., II, *Pottstown, Pa.* Gilbert, David F., *West Chester, Pa.* Goforth, Samuel T., Jr., *Columbia, S. C.* Goggins, C. Richard, *Claymont, Del.* Gooch, Ralph M., *Midland, Mich.* Grady, Paul H., *Haddonfield, N. J.* Greer, Wilbur, *Charleston, W. Va.* Griffith, Roger, *Charleston, W. Va.* Gunderson, Joseph M., *Lorain, Ohio.*

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• Naquin, Pennywitt J., III, *Texas City, Tex.* Novak, Jan, *Ontario, Canada.*

• Otterbacher, Rupert B., *Gary, Ind.*

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• Schoenbeck, L. C., *Wilmington, Del.* Schons, Joseph J., *Kuwait, Persian Gulf.* Schuessler, William A., Jr., *Lewiston, N. Y.* Schwanke, Richard, *Glen Ellyn, Ill.* Schwartz, Alfred L., *Hollis, N. Y.* Sharples, L. P., *Philadelphia, Pa.* Simmons, Robert Kirk, *Euclid, Ohio.* Skelton, Aubrey D., *Starkville, Miss.* Small, George E., *St. Louis, Mo.* Smilski, Michael T., *Sewell, N. J.* Smith, James Milton, *Texas City, Tex.* Spearman, James D., *Pasadena, Tex.* Spiller, Herbert A., *Decatur, Ala.* Stagg, Lester P., *Baton Rouge, La.* Steinberger, Robert L., *New York, N. Y.* Stuart, Glenn A.,

(*Continued on page* 150)

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CHEMICAL ENGINEER — B. Ch. E., M. S. March 1958. Age 27. Five years' experience in research and development. Desire well paying position with a growing company. Box 14-1.

(Continued on page 150)

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• Tenny, Dale E., *Denver, Colo.* Thomas, Robert L., *Cushing, Okla.* Trebilcock, John W., *Wilmington, Del.* Trisch, Joseph F., *Phoenixville, Pa.* Trischman, Charles A., Jr., *Texas City, Tex.*

• Von Pechmann, H. A., *Wilmington, Calif.* Von Rosenberg, Dale U., *Baton Rouge, La.* Vrablik, Edward R., *Palatine, Ill.*

• Wallis, Joseph H., Jr., *Delaware City, Del.* Weeks, Elizabeth Ann, *San Diego, Calif.* Weil, H. Gilbert, *Charleston, W. Va.* Weinauer, Dietrich E., *Wilmington, Del.* Whitehurst, Brooks M., *Richmond, Va.* Wilkinson, Loy, *South Charleston, W. Va.* Withers, Frank E., *Beaumont, Tex.* Woelzlein, Wilmar M., *Kirkwood, Mo.* Worley, F. L., Jr., *Houston, Tex.* Worstell, Jerry L., *St. Albans, W. Va.* Wright, Donald J., *Charleston, W. Va.* Wright, William R., *Baton Rouge, La.* Wu, Francis, *Trenton, Mich.*

• Zachares, Peter F., *Waldick, N. J.* Zalkind, Stanley, *Fall River, Mass.* Zumwalt, Robert E., *Army Chemical Center, Md.*

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• Chanmugam, J., *Princeton, N. J.*
• Glaze, Edwin L., *St. Paul, Minn.*
• Hatfield, Kent E., *Idaho Falls, Idaho.*
• Shores, William E., *Brandenburg, Ky.*

SITUATIONS WANTED

(*Continued from page* 149)

Ph.D.—With fourteen years' successful experience in process development and evaluation, process design, project engineering, management in petroleum, petrochemical and chemical industries. Seek senior academic post or high-salaried industrial position with progressive organization. Box 15-1.

PRODUCTION MANAGEMENT — B. Ch. E. Eleven years' experience including development work, polymerization, extrusion and injection molding of thermoplastics. Desire position of responsibility in related field. Age 35. Family. Present position Plant Manager. Box 16-1.

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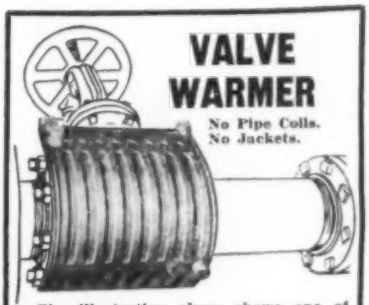

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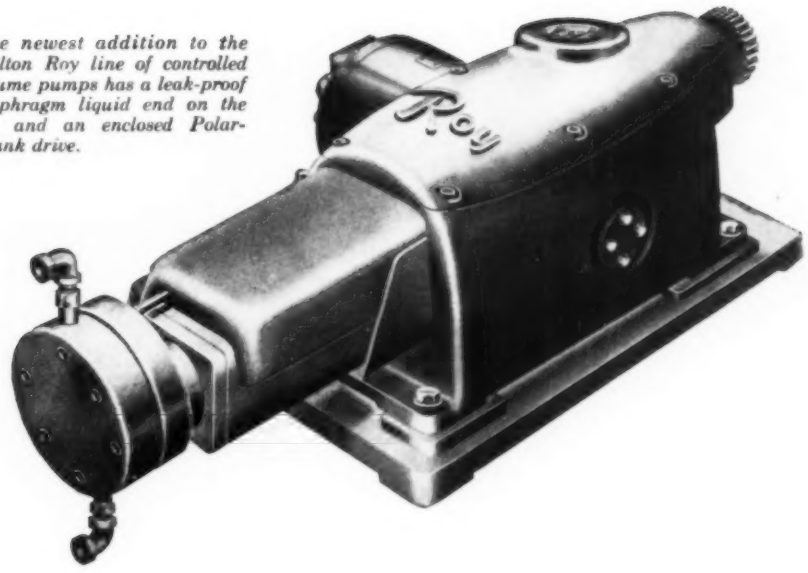
news and notes of A.I.Ch.E.

By the time you read this the new year will be under way & the resolutions which we made in a spirit of determination will be beginning to weigh a little heavy on our will power . . . In the Institute, however, plans for the year have been afoot for a long time . . . The year 1958 is shaping up as one of the most important years in Institute history . . . a year that will see the culmination of many projects . . . The A.I.Ch.E. is more than of age & in taking a prominent position in the world of engineering, as it will be doing in 1958, it will be giving the members an exciting review of what their professional organization is doing for the public, the engineering profession & the chemical industry . . . There will be several historic meetings in which the A.I.Ch.E. will play an important part . . . & our staff will have to be on its mettle if it is to bring off all the planned events successfully . . . Actually, if A.I.Ch.E. had the financing, it could easily use about three more good full-time assistants on the staff in order to ensure the smooth functioning of the coming events . . . The planning is practically finished for some of these jobs but just starting for others . . . & if anyone wonders why all our staff have harried, absent-minded looks on their faces during 1958 here is why . . . We begin with a Nuclear Congress, managed by A.I.Ch.E., in Chicago in March . . . we hold a meeting in Montreal with the Chemical Institute of Canada in April . . . in June we put the Fiftieth Anniversary of the Institute on the road in Philadelphia . . . in August we are hosting a Heat Transfer Conference at Northwestern University & running an exposition with it . . . in September we'll meet in Salt Lake City . . . & we'll wind up with an annual meeting in Cincinnati next December . . . In between times we shall publish four volumes of important papers for the Fiftieth Anniversary & help in a fund-raising campaign among the members for the new engineering center, which we hope to be in by 1960 . . . publish an anniversary issue of **Chemical Engineering Progress** in May, on which the editorial staff is now working to make it the most memorable in the history of chemical engineering publications . . . & during April play host along with the four other engineering societies to the secretaries of foreign groups who will be over here for a U.S.E.C. conference . . . U.S.E.C. is a society of engineering groups in Europe and North America organized for the purpose of exchanging information & experience. . . . **Council actions** at the meeting in Chicago in which the membership might be interested include approving financial forecasts for 1958 . . . considering representatives to the United Engineering Trustees & to the Engineering Foundation . . . appointing H. F. Nolting, a newly elected director, as Chairman of the Constitution & By-Laws Committee & L. D. Katz, the new Vice- president, as Chairman of the Sections Activities Committee . . . hearing a report from an *ad-hoc* committee headed by W. E. Lobo on awards to be given at the Fiftieth Anniversary Meeting . . . appointing a committee comprised of A. N. Hixson as chairman, J. C. Elgin as vice-chairman & Vincent W. Uhl, for the ceremonial session to be held in Philadelphia on Wednesday of the Jubilee Week . . . hearing a report on the progress of the Executive Committee in reaching an agreement with U.E.T. on contracts which will make us a founder member . . . approving a budget from the local committee on arrangements for the Fiftieth Anniversary Meeting reported by W. E. Chalfant, chairman of the committee, & W. M. Carlson, Chairman of the Finance Committee . . . voting the acceptance of rules and regulations of the Admissions Committee which have been modified in accordance with Council suggestions . . . **Also** at this meeting R. C. Kintner, Chairman of the Chemical Engineering Education Projects Committee, outlined procedures which his group hopes to follow next year & some of its current & future prorams . . . J. C. Dart, Chairman of the Institute Sections Committee, presented the final report of the group, which will be disbanded & its functions taken over by the Institute office . . . More committee reports will be summarized **next month** . . . Since this was the last Council meeting under the guidance of J. H. Rushton, Council expressed its appreciation of his leadership & also its sincere thanks to the retiring directors . . . **New Jersey Section** is dividing, having given its blessing to the formation of a North Jersey Section with Al Luhks of the Heyden Newport organization as chairman for the new section, J. F. Robertson as secretary, Lee Parker & Stan Adler as heads of the membership & program committees respectively & a constitution committee headed by Odon Knight.

-F.J.V.A.

The newest addition to the Milton Roy line of controlled volume pumps has a leak-proof diaphragm liquid end on the left and an enclosed Polar-Crank drive.



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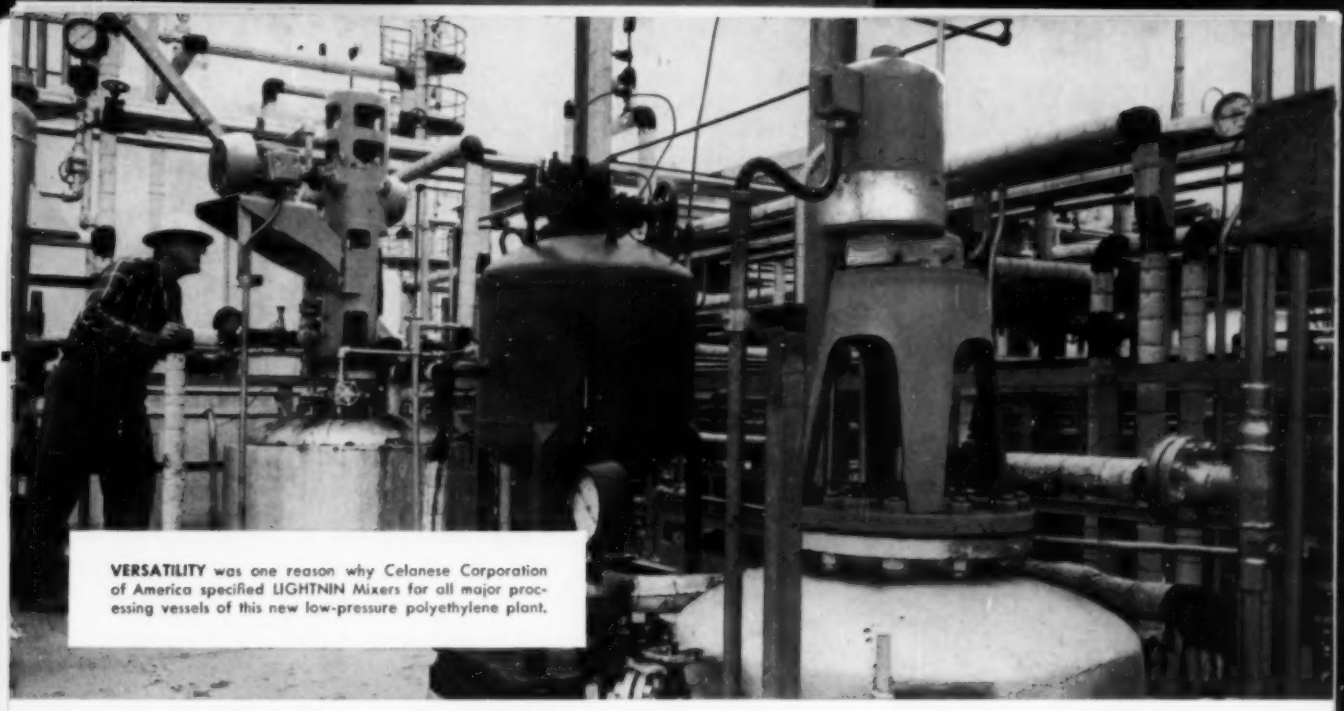

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